AD-A248 408

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FINAL ENVIRONMENTAL IMPACT STATEMENT (U)

19 SEPTEMBER 1991

[redacted]

Notice (U): [redacted]

CLASS BY: [redacted]
DECL: OADR

[redacted]

[redacted]

ADDENDUM TO THE ENVIRONMENTAL IMPACT STATEMENT FOR

[redacted]

30 September 1991

[redacted]

ADDENDUM TO FINAL ENVIRONMENTAL IMPACT STATEMENT (U)

(U) This addendum provides clarification and correction to some areas of the Final Environmental Impact Statement (FEIS) issued September 1991.

[redacted]

[redacted]

(U) Page 2.9-3, 2nd full para, 5th line: Insert "and the Nevada SHPO would be consulted" prior to the phrase "before construction of these lines commenced".

(U) Page 2.9-3, 2nd full para, 6th line: Change sentence to read "Mitigation measures would be implemented (such as modifying and rerouting the lines, and recovering any resources that are discovered) if required by the SHPO following consultation to reduce ..."

(U) Page 2.9-5, Health Impacts Table: Change "GA bounding case accident" to "GTA bounding case accident". In second footnote change "Mini-GA" to "Mini-GTA".

(U) Page 3.1-6, Figure 3.1-3: Change "NNFD Research Laboratory (NNFD-RL)" to "Lynchburg Technology Center (LTC)".

(U) Page 3.2-19, 2nd para, 2nd sentence: Change "predominate" to "predominant".

(U) Page 3.2-12, 3rd full para, line 2: Delete "in" and add comma after "NTS".

(U) Page 3.2-17, 3rd full para, 2nd line: Change " produce" to "are produced".

(U) Page 3.2-20, 4th full para, 5th line: Delete "between the Mojave and the Great Basin deserts at elevations of". This is repetitive.

(U) Page 3.2-25, 6th para, last two sentences: Change "above" to "below".

(U) Page 3.2-37, last para, 2nd sentence: Add to end of 2nd sentence "...and DOE Orders 5480.6 (Safety of DOE-owned Nuclear Reactors) and 5481.1B (Safety Analysis and Review System)".

(U) Page 4.1-1, 1st para, 3rd line: Add comma after "testing" and insert "and operation" after "construction".

(U) Page 4.1-1, 4th para, last line: Insert "environmental resource" before "subsection".

(U) Page 4.1-3, 1st full para, 4th line: Change "program" to "ground test facility".

(U) Page 4.2-4, 1st full para, 2nd line: Add comma after "requirements".

(U) Page 4.2-6, 4th paragraph, 8th and 9th sentences: Delete both sentences. Information is redundant.

(U) Page 4.2-7, 2nd full para, 3rd line: Insert "be" after "to".

(U) Page 4.3-1, 3rd para, 6th line: Change "either" to "both".

(U) Page 4.3-1, 3rd para, 7th line: Change "or" to "and".

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[redacted]

(U) Page 4.3-2, 2nd full para, 1st line: Change "is" to "has been".

(U) Page 4.3-2, 4th full para, 5th line: Change "regulation" to "regulations".

(U) Page 4.3-3, 3rd para, 1st and 2nd sentences: Delete from both sentences: "the high significance criteria level of".

(U) Page 4.3-3, 3rd, 8th line: Change "operations personnel" to "construction and operations personnel".

(U) Page 4.3-3, 4th para, 9th line: Change "construction" to "construction and operation".

(U) Page 4.3-7, 3rd full para, 3rd line: Delete "both".

(U) Page 4.3-7, top line: Change "induced" to "included".

(U) Page 4.3-11, fourth paragraph, first sentence: Change "18,000,000 ft^3" to "900,000 ft^3".

(U) Page 4.3-20, 1st para, last sentence: Add to beginning of sentence, "If applicable...".

(U) Page 4.3-35, 5th para: See General Clarification #2 above.

(U) Page 4.3-35, 5th para, 1st line: Change "negligible" to "high". See #__ for explanation on mitigations that result in insignificant environmental consequences.

(U) Page 4.4-1, 7th para, 6th line: Change "impose" to "pose".

(U) Page 4.4-2, 4th full para, 4th line: Change "regulation" to "regulations".

(U) Page 4.4-3, 2nd para, 1st line: Change "110 dBA" to "greater than 110 dBA".

(U) Page 4.4-3, 4th para, 1st and 2nd sentences: Delete from both sentences: "the high significance criteria level of".

(U) Page 4.4-3, 5th para, last sentence: Delete "However," from beginning of sentence.

(U) Page 4.4-5, 6th para, last line: Change "78.000 m^3" to "49,000 m^3".

(U) Page 4.4-6, 2nd full para: Mixed wastes are periodically transported off-site. Therefore, the remaining capacity would be more than the value currently given in the paragraph.

(U) Page 4.4-9, 5th para, 1st line: Change "affected," to "affected and".

(U) Page 4.4-10, 3rd para: Add to beginning of paragraph: "A reconnaissance-level biological resources survey conducted at the Quest site identified no threatened or endangered species (Section 3.2.2.3)." In first sentence change "pre-activity" to "detailed".

[redacted]

[redacted]

(U) Page 4.4-18, 4th para, 2nd sentence: Change "cultural and biological survey" to "cultural and biological resource surveys".

(U) Page 4.4-18, 5th para: See General Clarification #2 above.

(U) Page 4.5-2, third paragraph, 11th line: Change "impact" to "environmental consequences".

(U) Page 4.5-3, 1st line from top: Change "regulation" to "regulations".

(U) Page 4.5-3, 3rd line from top: Delete "the significance criteria".

(U) Page 4.5-3, 2nd full para, 1st line: Delete "the high significance criteria".

(U) Page 4.5-4, 2nd para, 3rd line: Change "insignificant" to "significant".

(U) Page 4.5-13, 2nd para: See General Clarification #2 above.

(U) Page 4.8-1, 4th para, 2nd sentence: Change "1×10^{-10}" to "7×10^{-6}" and "4×10^{-11}" to "2×10^{-6}".

(U) Page 4.8-2, 1st para, 2nd sentence: Change "1×10^{-10}" to "7×10^{-4}" and "4×10^{-11}" to "2×10^{-4}".

(U) Page 4.8-2, 2nd para: See General Clarification #2 above.

(U) Page 4.8-4, 3rd full para, 1st line: Change "would" to "could".

(U) Page A.3-4, 4th para 4, 4th sentence: After "where" insert "small quantities could be irradiated in existing facilities at SNL or transported to one of the".

(U) Page A.3-4, para 4, last sentence: After "irradiation" delete "small quantities could be irradiated in existing facilities at SNL or transported to one of the".

[redacted]

[redacted]

Corrections:

(U) Page Ex-4, 3rd full para, first line: Change "and" to "however".

(U) Page EX-7, Table EX-1: See General Clarification #2 above.

(U) Page Ex-8, 2nd para, first line: Change "and" to "and then".

(U) Page Ex-8, 1st para, 2nd sentence: Delete comma after "impacts" and insert "and the" before "potential". Also delete comma after "bunker".

(U) Page Ex-8, 5th para, 1st line: Delete comma after "surveyed".

(U) Page Ex-9, 1st full para, last sentence: Change to: "Therefore the environmental consequences would be insignificant.

(U) Page 2.3-6, 1st para, 4th line: Change "for" to "from" uranyl nitrate.

(U) Page 2.3-22, 1st para, 12th line: Replace "...of only 1 mrem/year, or 10% of..." with "...not to exceed...".

(U) Page 2.4-3, 4th para: Delete paragraph. This information is presented on page 4.3-12 as a site specific description.

(U) Page 2.4-8, 2nd para, 3rd line: Change "applicable standard" to "applicable standards".

(U) Page 2.4-8, 4th para: Delete 2 commas in text.

(U) Page 2.4-9, 1st full para, 12th line: Change "Track record" to "The track record".

(U) Page 2.4-10, 3rd para, last line: Change "populated areas" to "work areas".

(U) Page 2.8-2, 1st para: Delete "by more than 35 dBA".

(U) Page 2.8-2 - last para, last line: Change "accident" to "safety".

(U) Page 2.8-3, 1st para, 2nd line: Delete 2nd sentence. This is programmatic section.

(U) Page 2.8-5, 2nd para, 2nd line: Change "proposed testing location" to "proposed testing locations".

(U) Page 2.9-1, 3rd para, 8th line: Delete "environmental".

(U) Page 2.9-2, Table 2.9-1: See General Clarification #2 above.

(U) Page 2.9-3, top para, 1st line: Change "disrupted" to "disruptions".

[redacted]

[redacted]

TABLE EX-1A: SYNOPSIS OF SITE-SPECIFIC ENVIRONMENTAL IMPACTS (U)

Resource Area	Site	Intensity of Potential Impact				Mitigation Planned	Environmental Consequences
		Neg.	Low	Mod.	High		
Population & Economy	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					
Land Use & Infrastructure	SMTS	X				Where	
	QUEST		X			needed	Insignificant
	LOFT		X				
Noise	SMTS				X		
	QUEST				X	Yes	Insignificant
	LOFT				X		
Cultural Resources	SMTS		X			Where	
	QUEST		X			needed	Insignificant
	LOFT	X					
Safety (non-nuclear)	SMTS			X			
	QUEST			X		Yes	Insignificant
	LOFT			X			
Waste (LLW, TRU, MW, HW, SW)	SMTS	X				Where	
	QUEST		X			needed	Insignificant
	LOFT		X				
Topography	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					
Geology	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					
Seismic Activity	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					
Water Resources	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					
Meteorology/ Air Quality	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					
Biological Resources	SMTS		X				
	QUEST		X			Where	Insignificant
	LOFT	X				needed	
Radiological Normal Operations	SMTS				X		
	QUEST				X	Yes	Insignificant
	LOFT				X		
Radiological Accidents	SMTS	X					
	QUEST	X				No	Insignificant
	LOFT	X					

[redacted]

[redacted]

General Clarifications (U):

1. Radiological Impacts (U)

(U) This section provides clarification on radiological impact issues in Sections 2.8.6, 2.8.7, 2.9.7, 4.3.4, 4.4.4, and 4.5.4).

([redacted]) There are meteorological conditions that could result in exceedance of the predicted impacts expected under typical meteorological conditions described in the EIS sections referenced above. For example, under normal operations of a full-power QTA test (2000 MW for 1000 seconds), if the inversion layer height is 1,000 meters instead of 2,000 meters, the resulting dose to the maximally exposed individual would be 120 mrem. This would result in potentially significant impacts, specifically NESHAPs standards would be exceeded and increased cancer deaths would occur, if left unmitigated.

([redacted]) Testing under conditions that exceed NESHAP would also result in higher doses to the population as a whole. For example, at NTS, a QTA run of 2000 MW for 1000 seconds during a 5.5 m/s wind blowing toward 260°, a stability Class D, and an inversion layer height of 1000 meters, would expose the population to a dose of 8.2×10^4 person-mrem. Predicted health effects would increase from 1188 to 1188.07 cancer fatalities and 119 to 119.02 genetic defects for this unmitigated test.

([redacted]) Testing under conditions that exceed NESHAP would increase doses to the population near INEL as well. For example, a QTA run of 2000 MW for 1000 seconds during a 5.5 m/s wind blowing toward 100°, a stability Class D, and an inversion layer height of 1000 meters, would expose the population to a dose of 1.9×10^4 person-mrem. Predicted health effects would increase from 28,049 to 28,051 cancer fatalities (a predicted increase of 2 cancer fatalities) and 2,550 to 2,550.5 genetic defects for the unmitigated case.

(U) These potentially significant impacts of exceeding standards and of increased health effects would be mitigated to insignificance by restricting testing such that the impacts would be limited to those described in the Maximum Offsite Individual Dose and Population paragraphs in sections 4.3.4.2.1, 4.4.4.2.1, and 4.5.4.2.1. This would be accomplished by monitoring and then modeling actual meteorological conditions [along with other planned test parameters (i.e. power level and test duration), as described in 2.9.7 of the FEIS] prior to each test. No tests would be conducted if the resultant predicted dose to the maximally exposed individual exceeds the impacts described in those sections above.

(U) Since normal operations without restriction would cause a potential exceedance of NESHAP limits, and this is not permissible, analysis of the impacts of an accident under unmitigated test conditions is not necessary as testing would not occur.

Per Ltr

Availability Codes

Dist	Avail and/or Special
A-1	

[redacted]

[redacted]

2. Radiological Mitigations (U)

(U) Impact analysis presented in Sections 4.3.4.2.1, 4.4.4.2.1 and 4.5.4.2.1 and summarized in Sections 2.8 and 2.9 assess the radiological effects of testing under "program model conditions". These program model conditions include restrictions on meteorological and test conditions such that impacts are negligible and the environmental consequences are insignificant. Since unrestricted combinations of meteorological and test conditions exist that could result in significant radiological impacts, these impacts can be considered high and potentially significant but mitigable to insignificant as shown on the attached Table EX-1A which supersedes Tables EX-1 and 2.9-1, and as discussed in the addendum to the EIS.

3. Noise and Safety Impacts (U)

(U) The environmental consequences of noise impacts and safety impacts are potentially significant prior to mitigation but are mitigable to insignificant. Hence, references to both noise and safety environmental consequences after mitigation are corrected to insignificant. This is also shown on Table EX-1A which supersedes Tables EX-1 and 2.9-1.

[redacted]

EXECUTIVE SUMMARY (U)

A program has been proposed

INTRODUCTION (U)

([redacted]) In a program known as [redacted] ([redacted]), the [redacted] ([redacted]), as the lead agency, and the U. S. Air Force (USAF), as the continuing lead service, propose to develop the technology and demonstrate the feasibility of a high-temperature particle bed reactor (PBR) propulsion system to be used to power an advanced second stage nuclear rocket engine.

([redacted]) The advantages of such a nuclear propulsion system are attributable to its potentially very high specific impulse (Isp) capability and its relatively low weight. Isp is a measure of the effectiveness of a rocket engine and is expressed in units of time (seconds); it literally represents the capability of generating a unit of force (pounds) for a given period of time (seconds) for a given unit of propellant weight (pounds). The objective of the [redacted] program is to develop a PBR rocket engine having an Isp of approximately 850 seconds and a thrust to weight ratio of 30 to 40. This would be double the Isp of an advanced liquid fuel rocket engine and triple the Isp of an advanced solid fuel rocket engine of comparable weight.

([redacted]) A PBR propulsion system would allow the design of a rocket which could achieve extremely high accelerations, [redacted]. Technology developed in the [redacted] program would benefit a variety of other military and civilian missions as well.

([redacted]) Development and demonstration of the PBR technology includes the development, fabrication, assembly and testing of materials and components, and the design and construction of a ground test facility. These facilities would be used for testing of nuclear subassemblies and reactors and for ground qualification of a PBR rocket engine.

(U) The purpose of this Final Environmental Impact Statement (FEIS), developed in accordance with Council on Environmental Quality (CEQ) Regulation 40 CFR 1505.2, is to assess the potential environmental impacts of component development and testing, construction of ground test facilities, and ground testing ~~of the assembled~~ system.

([redacted]) The goal of the [redacted] program is the [redacted] of PBR rocket engine technology. The environmental impacts of flight testing will be assessed in a subsequent environmental analysis.

[redacted]

PROPOSED ACTION AND ALTERNATIVES (U)

([redacted]) The general concept of the [redacted] PBR rocket engine involves use of a remotely controlled reactor that heats cryogenic hydrogen propellant to very high temperature gaseous hydrogen that is expanded and exhausted in the engine nozzle to produce thrust.

([redacted]) Activities involved in the proposed action consist principally of 1) development and testing of the PBR engine and propellant components, assemblies, and systems; and 2) construction and operation of a ground testing facility.

([redacted]) Major technological issues and goals of the [redacted] program include the achievement and control of predicted nuclear power levels; the development of materials that can withstand the extremely high operating temperatures and hydrogen flow environments; and the reliable control of cryogenic hydrogen and hot gaseous hydrogen propellant. The testing process is designed to minimize radiation exposure to the environment. A major goal of the program would be to develop fuel particles that would minimize losses of fission products. Tests carried out for the program would progress systematically from initial nuclear tests and experiments to verify the PBR concept and to support the basic reactor design development; to laboratory tests of materials for reactor and nozzle components; to laboratory and field tests of reactor, nozzle, and propellant assemblies; to open-cycle subsystem integration tests; and engine demonstration and qualification tests. These tests would include some deliberate tests to failure of the fuel and fuel elements to characterize fuel mechanisms and margins.

pg EX-7)

([redacted]) The principal components of the engine subsystem are the Particle Bed Reactor (PBR), the Nozzle Assembly, and the Propellant Management System (PMS). The Particle Bed Reactor consists of a core of [redacted] fuel elements arranged in a [redacted], surrounded by a neutron moderating material. Each individual fuel element contains millions of fuel particles consisting of a kernel of fissile material surrounded by one or more protective coatings, each nominally [redacted] in diameter. Cryogenic liquid hydrogen (LH_2) at 25-30 K (-250 to -240° C) enters the reactor assembly at the reactor dome. The hydrogen is admitted to each fuel element, moves across the particle bed where it is heated to approximately 3000 K (2730° C), and then passes out through the nozzle, where it is expanded for propulsion. This system is projected to generate a power level of 2,000 megawatts (MW). The Propellant Management System provides controlled flow and pressure to the engine and ancillary subsystem. The system consists of the tank isolation valves, pump discharge valve, flowmeter, temperature control valve, mixing chamber, speed control valve and turbopump assembly.

Ground Test Facility (U)

(U) One location at the DOE Nevada Test Site (NTS) and two locations at the DOE Idaho National Engineering Laboratory (INEL) have been identified as reasonable alternatives for a ground test station.

(U) The ground test facility would be constructed in two phases. The sub-scale facility would include a control bunker, data acquisition and instrumentation/control systems, a receiving and assembly facility, a test cell, a coolant supply system (hydrogen and helium), an effluent

[redacted]

treatment system, a remote inspection and maintenance system, roads and services, and safeguards and physical security. Upon satisfactory completion of tests conducted at the sub-scale facility, the test station would be modified to the full-scale facility. Several components would be added to the existing sub-scale facility to create a full-scale facility. These include a disassembly building, a test evaluation center and additional coolant storage.

(U) An Effluent Treatment System (ETS) would be designed to remove from the effluent, radioactive material generated as a result of the proposed ground testing activities. The radioactive emissions would be reduced to a level that is consistent with the current as low as reasonably achievable (ALARA) program principles.

([redacted]) The effluent treatment system would be designed to accomplish the following objectives: 1) ensure that radioactive fuel material entering the ETS remains in a subcritical geometry; 2) cool the test article effluent to temperatures acceptable for normal engineering materials used in gas treatment systems; 3) remove particulates and debris from the effluent stream; 4) remove nobel gases, halogens, and vapor phase contaminants from the effluent stream; and 5) flare the hydrogen gas to the atmosphere. The ETS may be removed for full scale testing if it is demonstrated that the fission product inventory can be contained and the impacts would be insignificant.

Ground Testing (U)

([redacted]) The philosophy of the ground testing activities is to gradually approach prototypical conditions anticipated to be experienced during a test flight. The proposed system ground testing would demonstrate the technology through a series of tests over a five or more year period leading to the qualification of the Particle Bed Reactor (PBR) engine for a flight test. In general, the ground tests are sequenced to commence with fuel element testing, progress through multiple assemblies that gradually approach prototypic conditions, and culminate in a prototypic assembly fully qualified for application to a flight vehicle. Specifically, this test series includes the Particle Bed Reactor Integral Performance Element Tests (PIPET) and the Engine Integration Tests (EIT) as well as tests of the Mini Ground Test Article (mini-GTA), the full-scale Ground Test Article (GTA) and the Qualification Test Article (QTA).

([redacted]) PIPET: The PIPET test would be the first self-sustained, power producing PBR test. This test would demonstrate the reactor fuel element operation at prototypic power densities, temperatures, pressures, flow rates, and power durations. Each [redacted] could be subjected to 5 operating cycles at a maximum power level of 550 MW_{th} for as long as 500 seconds per cycle, with a minimum of 7 days separating each operating cycle.

([redacted]) Engine Integration Tests (EIT): Engine Integration Tests (EITs) would be conducted to demonstrate the propellant management system without an operating reactor in the loop.

([redacted]) Ground Test Article (GTA): The mini-GTAs are seven element cores designed to represent more closely a prototypic full size GTA PBR and would be operated similar to the PIPET in the sub-scale facility test cell. The full-scale GTA test series would demonstrate a complete [redacted] PBR operation with feed and control hardware and a full complement of

instrumentation including the prototype planned flight sensors. These tests would demonstrate controllability and stability at full power and rapid start-up and shutdown under computer control over a simulated full mission profile. The maximum time at full reactor power for any individual core assembly of the GTA test series is anticipated to be approximately 1000 seconds.

([redacted]) Qualification Test Article (QTA): The Qualification Test Article (QTA) is an engine which simulates the operation of the complete engine system at near prototypical flight conditions. The engine would 1) represent the flight engine hardware and software and the planned full flight mission profile firing including fast start ([redacted]) and 2) qualify the engine and control system for the flight test.

Flight Testing (U)

([redacted]) Upon successful completion of ground testing, [redacted].

(U) The flight test is not part of the proposed action analyzed in detail in the FEIS and, prior to a decision and a commitment of resources to flight test, formal NEPA documentation would be prepared to assess the environmental impacts of flight testing.

ENVIRONMENTAL CONSIDERATIONS (U)

(U) Environmental consequences associated with the proposed action, the no action alternative, and three ground testing site alternatives are addressed in Chapter 4.0. The no action alternative would result in no environmental consequences because materials and component development and ground testing would not be conducted.

(U) Potential impacts and environmental consequences are addressed at the programmatic and site specific level. At the programmatic level, waste would be stored on the installation where testing would take place or be handled in existing process streams, resulting in low potential impacts. Cultural resource and biological resource surveys would be conducted for any area not previously surveyed and the appropriate State Historic Preservation Officer would be contacted prior to conducting any program activities.

(U) Radiological impacts were calculated for the maximally exposed individual and total downwind population for normal operations and the bounding case accident scenario. Results were found to be well within applicable standards and indicate that the predicted increased risk of health effects to the individual or the predicted increased health effects to the population are sufficiently small that no effects are expected and the environmental consequences are insignificant.

(U) Consideration of these impacts and mitigations in their full context has led to the determination that the [redacted] Program would have insignificant programmatic environmental consequences.

([redacted]) The principal participants of the [redacted] program include: (1) Brookhaven National Laboratory (BNL) in Upton, NY; (2) Babcock and Wilcox (B&W) Naval Nuclear Fuel Division (NNFD) in Lynchburg, VA; (3) Sandia National Laboratories (SNL) in Albuquerque, NM; (4) Aerojet Propulsion Division of GENCORP in Sacramento, CA; (5) Hercules Aerospace Corporation in Magna, UT; (6) Garrett Fluid Systems Division (of Allied-Signal Aerospace Company) in Tempe and San Tan, AZ; (7) Airesearch Los Angeles Division (ALAD) (of Allied Signal Company) in Torrance, CA; (8) Grumman Space Electronics Division in Bethpage, NY; (9) Raytheon Services Nevada (RSN) in Las Vegas, NV; (10) Reynolds Electrical and Engineering Company, Inc. (REECo) in Las Vegas, NV; (11) Fluor-Daniel, Inc. (FDI) in Irvine, CA; (12) the [redacted] ([redacted]) in Washington, DC; (13) the Department of Energy Headquarters in Washington, DC; (14) Idaho National Engineering Laboratory near Idaho Falls, ID; (15) the Nevada Test Site near Las Vegas, NV; (16) USAF Phillips Laboratory in Albuquerque, NM; and (17) the U.S. Army Corps of Engineers - Huntsville Division (USACE-HND) in Huntsville, AL.

([redacted]) Three site alternatives were considered for the [redacted] ground testing facility. These include the SMTS site at the Nevada Test Site and the QUEST site or LOFT facility at Idaho National Engineering Laboratories. The SMTS, QUEST, and LOFT alternatives are all viable ground test facility sites. A compilation of site-specific environmental impacts are presented in Table EX-1.

(U) Both the NTS and INEL installations are remote from population centers in regions that have a relatively dry climate. The topography of the NTS is typical of much of the Basin and Range physiographic province with elevations ranging from 910 to 1,370 meters (3,000 to 4,500 ft). Annual precipitation in Southern Nevada is approximately 10 centimeters (4 inches). INEL, situated in a flat valley surrounded by mountains, is located in a region that exhibits semi-arid characteristics with an annual average precipitation of 22 centimeters (9 inches). Elevations at INEL range from 1,430 to 1,580 meters (4,700 to 5,200 ft).

(U) The potential environmental consequences of the proposed action shown in Table EX-1 were assessed for the following environmental resources:

- Population and economy - The maximum employment of 100 construction and 60 operational employees would be available from the existing NTS and INEL work force.

- Land use and infrastructure - Land required for the ground test facility would be less than 0.03 percent of the total area of either the NTS or INEL installation.

- Noise - OSHA safety standards would be maintained for program employees by enclosure in a bunker during testing and the use of protective equipment. The general public would be far beyond any noise impacts.

- Cultural resources - Cultural resource surveys would be conducted for any areas not previously surveyed prior to any construction activities.

[redacted]

- Safety - Worker training programs and facility design safety features would be implemented to reduce the probability of potential accidents from the handling and storage of hydrogen, helium, and oxygen.

- Waste management - Waste would be handled in existing process streams at NTS or INEL in compliance with all applicable environmental regulations.

- Topography - construction and operation of the facility would be limited to a small portion of NTS or INEL installation and have minimal effect on topography.

- Geology - There would be a negligible impact on geologic resources at any of the three sites.

- Seismology and volcanism - There would be no impact associated with seismology or volcanism at any of the three sites.

- Water resources - There would be no measurable change in the water resource levels nor any significant degradation to water quality at NTS or INEL.

- Meteorology and air quality - There would be a slight and temporary increase in air pollution from the use of heavy equipment during the construction period.

- Biological resources - Biological resource surveys would be conducted prior to any construction activities for those areas not previously surveyed.

- Radiological environment - The very low dose to the maximally exposed individual or total downwind population would be well within all applicable standards.

(U) There were some differences indicated between sites for potential impact levels for land use and infrastructure. Land use impacts would be negligible at SMTS but low at QUEST and LOFT because grazing areas at the latter two sites may be temporarily disrupted by testing activities. In the context of the total grazing land available, however, the environmental consequence of this impact would be insignificant. Also, public roads cross the INEL installation. As a result, potential infrastructure impacts would be negligible at SMTS, but low at QUEST and LOFT if public roads have to be closed during test runs. Because closings would be temporary and infrequent and because alternate routes are available, environmental consequences would be insignificant.

[redacted]

(cont) Environmental impact and mitigation planning are included for the following areas of concern:

[redacted]

TABLE EX-1:
SYNOPSIS OF SITE-SPECIFIC ENVIRONMENTAL IMPACTS (U)

Resource Area	Site	Intensity of Potential Impact				Mitigation Planned	Environmental Consequences
		Neg.	Low	Mod.	High		
(1) Population & Economy;	SMTS QUEST LOFT	X X X				No	Insignificant
(2) Land Use & Infrastructure;	SMTS QUEST LOFT	X	 X X			Where needed	Insignificant
(3) Noise;	SMTS QUEST LOFT				X X X	Yes	Potentially[1] Significant
(4) Cultural Resources;	SMTS QUEST LOFT	 X	X X			Where needed	Insignificant
(5) Safety (non-nuclear);	SMTS QUEST LOFT			X X X		Yes	Potentially[1] Significant
(6) Waste; (LLW, TRU, MW, HW, SW)	SMTS QUEST LOFT	X	 X X			Where needed	Insignificant
(7) Topography;	SMTS QUEST LOFT	X X X				No	Insignificant
(8) Geology;	SMTS QUEST LOFT	X X X				No	Insignificant
(9) Seismic Activity;	SMTS QUEST LOFT	X X X				No	Insignificant
(10) Water Resources;	SMTS QUEST LOFT	X X X				No	Insignificant
(11) Meteorology/ Air Quality;	SMTS QUEST LOFT	X X X				No	Insignificant
(12) Biological Resources;	SMTS QUEST LOFT	 X	X X			Where needed	Insignificant
(13) Radiological Normal Operations;	SMTS QUEST LOFT	X X X				No	Insignificant
(14) Radiological Accidents;	SMTS QUEST LOFT	X X X				No	Insignificant

[1] (U)Potentially significant environmental consequences would be mitigated to insignificant levels as discussed in Chapter 4.

(15) Soils; and (16) Wildlife habitats.

[redacted]

(U) Potential noise impacts would be high and environmental consequences would be potentially significant at all three sites. However, since the general public would be far beyond the area of noise impacts, potential impacts to the few workers exposed during testing would be mitigated by their enclosure in a bunker, and the use of protective safety equipment, the environmental consequences would be insignificant.

(U) Cultural resource surveys would be conducted for areas not previously surveyed and the State Historic Preservation Office (SHPO) would be consulted prior to any program activity. Mitigation measurers would be implemented if required by the SHPO.

(U) Potential safety impacts would be moderate and environmental consequences would be potentially significant at all three sites. However, because of extensive training and precautionary preparation and because of the safety design features of the facility, there is a low probability of an accident, and the environmental consequences would be insignificant.

(U) Waste impacts would be negligible at NTS and low at QUEST and LOFT. All wastes would be handled within existing process streams and would be in compliance with all existing environmental regulations and not require exceptional procedures. In this context, environmental consequences would be insignificant at the three alternative sites.

(U) Biological resource surveys would be conducted for any area not previously surveyed, and, if required, the FWS would be consulted prior to any program activities.

(U) The calculations of the effects to humans of low levels of radiation are predicted by the MACCS model developed for the U.S. Nuclear Regulatory Commission. This model was developed for predicting radiological impacts associated with releases from severe accidents involving terrestrial nuclear power plants. The model depends upon a set of "program model conditions" which include assumptions of fuel particle integrity, test run times and power levels, ETS performance and meteorological conditions. (These program model conditions are described fully in Section 4.3.4.)

(U) Normal Operations - The program model conditions would result in a radiological dose from normal operations to a hypothetical "maximally exposed individual" and to the downwind population which would be well below NESHAP standards. Modeling of the dose effect of the facility from normal operations indicates that the predicted additional risk of health effects to the individual and the predicted additional health effects to the population are sufficiently small that no health effects are expected to occur from radiation exposure at the program model conditions. These impacts are considered negligible and would result in insignificant environmental consequences.

([redacted]) Bounding Case Accident Scenario - Calculations of the impacts of radiological doses resulting from the hypothetical bounding case accident scenario under program model conditions were determined by the MACCS model. This hypothetical bounding case accident assumes that the total isotope inventory at the end of the longest run becomes the source term. The design base accident would be determined during the safety analyis process and would be some fraction of the hypothetical bounding case. Such an accident could only occur during test activities.

There is no risk of the bounding case accident between the test periods, which are expected to be 10 to 20 minutes long, and spaced 1 or more weeks apart.

(S) The [redacted] accident scenario would result in a dose to a maximally exposed individual and to the downwind population of an accident which would not exceed applicable ANSI/ANS 15.7 accident standards. Modeling of the dose effect of the facility from normal operations indicates that the predicted additional risk of health effects to the individual and the predicted additional health effects to the population are sufficiently small that no health effects are expected to occur from radiation exposure at the program model conditions. The environmental consequences for the maximally exposed individual would be insignificant.

(U) The potential environmental consequences discussed above for radiological impacts are based on the "program model conditions" described in 4.0. The safety and environmental impacts of radioactive releases are based on a number of factors which directly affect the exposure to site workers, installation workers, and members of the general public. Based on the best available information, including conservative engineering judgements of fuel particles and fuel element characteristics, ETS design, required run time and power levels, and assumed meteorological conditions, all applicable standards are shown to be met. The analysis indicates that potential radiological impacts are well within applicable standards for the modeled meteorological conditions. As the technology is developed, additional information may indicate that test conditions can be redefined to allow greater flexibility and maintain radiological hazards within limits set by applicable standards. Also, this information would allow the identification of measures to reduce hazards to as low as reasonably achievable.

(U) The testing program would define, compatible with testing objectives, the appropriate set of conditions under which tests would be conducted such that radiological releases would be within all applicable standards. To ensure that these established conditions can be achieved, the testing program would be subjected to the Safety Analysis Report process as required by DOE Order 5480.6, "Safety of Department of Energy-Owned Nuclear Reactors."

CONCLUSION (U)

([redacted]) Although the SMTS, QUEST, and LOFT sites all would be suitable for conducting the [redacted] program, radiological exposure would be less at SMTS because of the greater distance to the site boundaries and lower population around the site.

(U) Consideration of potential impacts and mitigation in their full context has led to the determination that construction and testing associated with the [redacted] program at any of the three alternative sites would result in no significant environmental consequences. Prior to a decision and a commitment of resources to flight test, formal NEPA documentation would be prepared to assess the environmental impacts of flight testing.

(U) The No-Action alternative (i.e., discontinuing the program) would result in no construction or testing impacts and would preclude development of the PBR technology.

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1.0 PURPOSE AND NEED FOR PROPOSED ACTION (U)

([redacted]) In a program known as [redacted] ([redacted]), the [redacted] ([redacted]), as the initial lead agency, and the U. S. Air Force (USAF), as the continuing lead service, propose to develop the technology and demonstrate the feasibility of a high-temperature particle bed reactor (PBR) propulsion system to be used to power an advanced second stage nuclear rocket engine. Following material and component development and PBR engine ground testing, [redacted].

1.1 PURPOSE OF THE PROPOSED ACTION (U)

([redacted]) The [redacted] is continually seeking to develop and improve upon the most advanced and effective propulsion systems for the major components of a [redacted]. In support of this continuing effort, a PBR propulsion system is being considered by the [redacted] and the USAF for use [redacted] indicate that the potential performance of PBR propulsion systems greatly exceeds that of systems using cryogenic liquids or solid fuels. The studies show that other propulsion systems cannot equal the potential performance of PBR engines even when scaled to very large size vehicles. For example, to achieve results similar to a second stage PBR propulsion system would require a conventional propulsion system (solids or liquids) that would weigh 3-5 times more than PBR systems. The relatively low weight of the PBR propulsion system allows the design of a rocket that is approximately the size of the current Peace Keeper vehicle (Grumman, 1988; Lenard, 1988; Falco, 1990; DOD, 1991).

([redacted]) The advantages of such a nuclear propulsion system are attributable to its potentially very high specific impulse (Isp) capability and its relatively low weight. Isp is a measure of the effectiveness of a rocket engine and is expressed in units of time (seconds); it literally represents the capability of generating a unit of force (pounds) for a given period of time (seconds) for a given unit of propellant weight (pounds). The objective of the [redacted] program is to develop a PBR rocket engine having an Isp of approximately 850 seconds and a thrust to weight ratio of 30 to 40. This would be double the Isp of an advanced liquid fuel rocket engine and triple the Isp of an advanced solid fuel rocket engine of comparable weight (Falco, 1990).

([redacted]) The PBR nuclear rocket engine therefore is directly applicable [redacted] and is uniquely qualified to perform a number of key military missions, many of which cannot be performed by chemical propulsion systems because of their much lower Isp. Specifically, the PBR would probably reach 900 seconds and may well exceed 1000 seconds of Isp. Chemical rocket technology, by contrast, is not expected to achieve performance gains much beyond current levels, or at best reach 500 seconds of Isp (Venetoklis, 1991).

([redacted]) Such a PBR propulsion system would allow the design of a rocket which could achieve extremely high accelerations, [redacted]. Analyses have shown that the use of PBR-powered rockets for [redacted] cryogenic or solid fuels (Falco, 1990). This could represent a significant increase [redacted], and an accompanying decrease in the requirements for [redacted] (Horan, 1990b).

([redacted]) The PBR also offers advantages over chemical systems by permitting the use of a much lighter vehicle for the same payload, or by increasing the payload capability for the same vehicle mass. Minimizing flight time is an important requirement of the [redacted] missions sensitive to engine thrust-to-weight ratios. The thrust-to-weight ratio for the PBR propulsion system makes the engine mass a much less significant portion of the overall vehicle mass and enables the deployment of effective, compact second stages which would assist in [redacted] (Venetoklis, 1991). Development of PBR technology would provide a range of options not presently available for [redacted].

([redacted]) Other potential military uses of the PBR technology include, but are not limited to: deployment of [redacted] (Venetoklis, 1991).

([redacted]) The performance offered by the PBR propulsion system offers unique capabilities to military mission planners in terms of increased available impulse, reduced weight, and reduced complexity. The PBR's high Isp and compactness provide a substantial improvement to rocket engine performance, and make it a valuable asset to military planners (Venetoklis, 1991).

([redacted]) To develop and demonstrate the feasibility of implementing the capabilities of a PBR propulsion system, the [redacted] is undertaking this research program using a phased or incremental approach. The innovative technologies involved in reaching the [redacted] program objectives require that many experimental activities take place that address the design, fabrication, testing, and analyses of the nuclear and non-nuclear components. These components consist of nuclear fuel elements and reactor components, attitude control systems, propellent flow-control systems, turbo pumps, and engine nozzles.

([redacted]) Also, as an integral part of the development program, a ground test station is proposed to be designed, constructed and operated to provide facilities for testing of nuclear assemblies and reactors and for ground qualification of a PBR rocket engine.

([redacted]) The [redacted] has entered into agreements with the USAF and the Department of Energy (DOE) to develop and test this technology. The goal is to develop a nuclear rocket engine that provides significant performance advantages over chemical rocket engines and to demonstrate minimal environmental and safety risk. The [redacted], USAF, DOE and National Aeronautics and

[redacted]

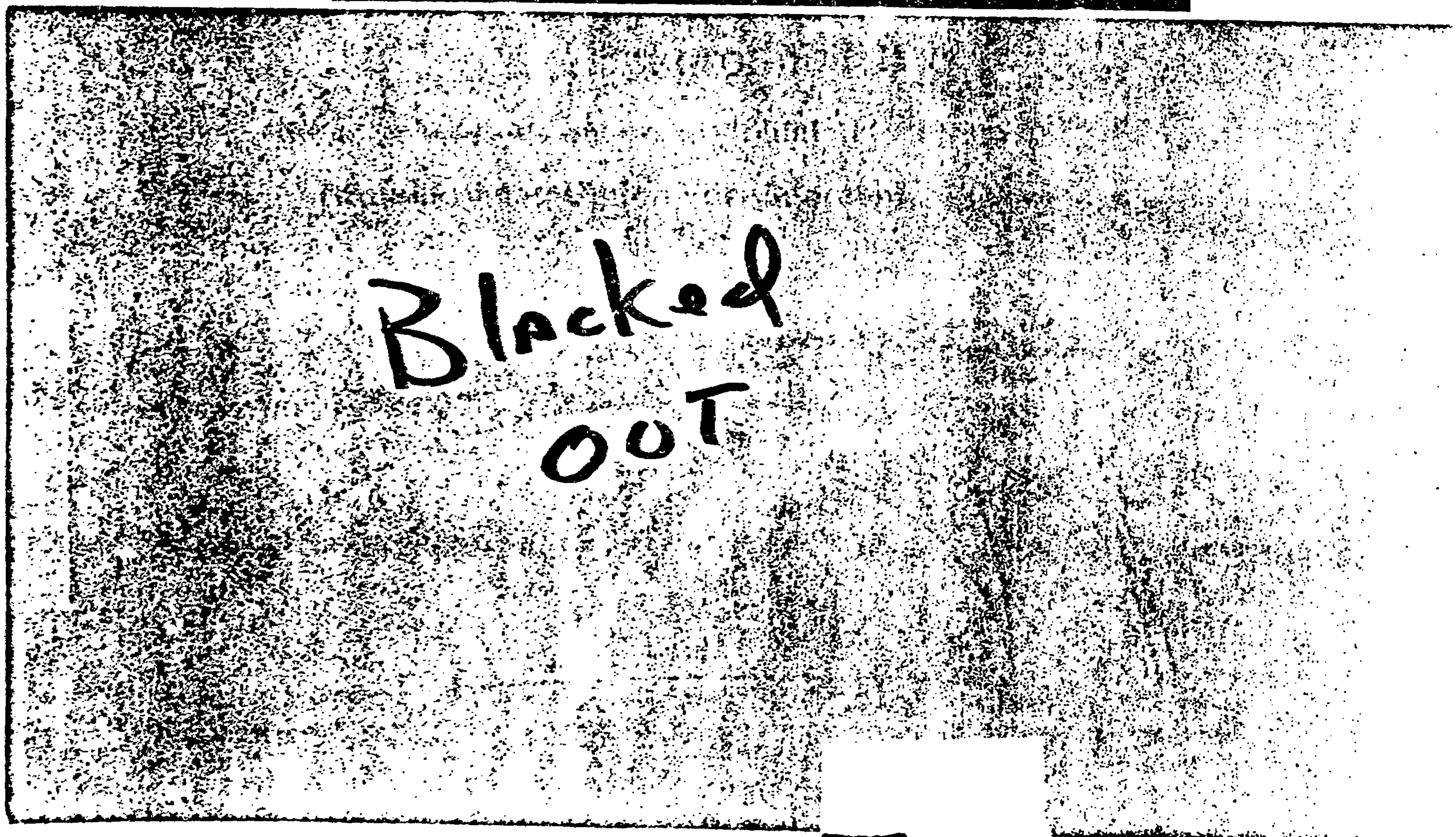

Figure 1.1-1 [redacted]

[redacted]

[redacted]

Space Administration (NASA) are all providing technical expertise to support attaining these goals.

([redacted]) As the lead agency, the [redacted] is preparing this Environmental Impact Statement (EIS) to analyze the environmental consequences of the nuclear rocket engine development program as required by the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations that implement the Act (40 CFR 1500-1508), Department of Defense (DOD) Directive 6050.1, and by DOE Order 5440.1D. The purpose of the EIS is to analyze the impacts of implementing actions and their alternatives, and to develop appropriate mitigation measures. The DOE and the USAF are cooperating agents for the EIS, due to their expertise in the technology and DOE's role as host for the ground test site and the USAF's role as successor lead agency. While the [redacted] will be involved through completion of the construction of the subscale ground test facility, the USAF will continue the implementation of the [redacted] program through the full scale ground test and qualification of the PBR reactor engine. The DOE, as a cooperating agency, will host the ground test operation at a DOE installation.

(U) A decision to engage in this technology research program does not constitute a decision to perform a flight test, engage in manufacturing or deploy the technology.

[redacted]

1.2 SCOPE AND STRUCTURE OF THE EIS (U)

([redacted]) This EIS assists the decision maker in evaluating the following two main issues: 1) whether or not to continue PBR technology development through ground testing (programmatic decision), and 2) where the ground testing should take place (site specific decision).

(U) The EIS assesses the potential environmental impacts of component development and testing; construction of ground test facilities; and ground testing of the assembled system. The decision to flight test will be made in the future. The impacts of a flight test are addressed in this EIS in a broad programmtic sense; supplemental NEPA analysis would assess the detailed environmental impacts of flight testing.

([redacted]) The description of the proposed action as well as a discussion of alternatives to the proposed action appear in Section 2.0. The description of the proposed action is organized according to the specialized research, development, and test activities required for the development of the PBR rocket engine, including a discussion of the system ground tests series, construction and operation of a new ground test facility, and the flight test. In Section 3.0, the test facilities and alternative sites are described individually as part of the affected environment. In Section 4.0, potential environmental consequences and mitigation activities are described for the proposed action and alternatives.

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES (U)

2.1 OVERVIEW (U)

2.1.1 Introduction (U)

([redacted]) [redacted] proposes to develop the technology and demonstrate the feasibility of a high-temperature particle bed reactor propulsion system to be used to power an advanced second stage nuclear rocket engine. The system arrangement for the experimental rocket is shown in Figure 2.1-1. The general concept of the [redacted] nuclear rocket involves use of a reactor that heats cryogenic hydrogen propellant to very high temperature gaseous hydrogen that is expanded and exhausted through the engine nozzle to produce thrust. Activities involved in the proposed action consist principally of 1) development and testing of the engine and propellant management system components and assemblies; and 2) construction and operation of ground testing facilities.

2.1.2 History of Program (U)

([redacted]) In 1982, scientists at the Brookhaven National Laboratory (BNL) developed the concept of the PBR. Soon after establishment of the [redacted], the PBR was recognized as an enabling technology for a number of potential military missions requiring an advanced propulsion system. In 1987, [redacted] assembled an industry/National Laboratories team to carry out the [redacted] ([redacted]) Program. (The participants and their responsibilities are described further in Section 2.3.1.)

([redacted]) A research development and testing program schedule was established and by December 1989, the program had made significant progress in verifying the PBR concept. Progress had been made in completing preliminary design reviews; in development of the manufacturing process; in development and testing of reactor components and materials; and in developing environmental and safety criteria of engine and vehicle components for system tests (Figure 2.1-2).

([redacted]) Preliminary designs have been completed and reviews have been conducted on various elements of the engine and vehicle, including the engine nozzle, the nose cone and its separation systems, the carbon fiber propellant tank and liner, the stage separation system, the upper stage structure, the interstage structure between the booster and the upper stage, the stage propellant start and feed systems, the cryogenic turbopump assembly, the inertial navigation systems, the attitude control systems, the command destruct system, and the ground to vehicle communications system. Manufacturing processes development addressed fuel particles, fuel elements, engine nozzles and turbopump components. The development testing for reactor components included hydrogen blowdown tests on candidate fuel particles and frits, particle heating tests, particle nuclear tests, pulsed irradiation of fuel elements, reactor critical experiments, and materials testing.

([redacted]) The early development work demonstrated the technical potential of a PBR rocket engine and concluded that work could proceed without encountering unacceptable safety hazards. Each DOD service secretary endorsed the program (Aldridge, 1988; Atwood, 1989; Marsh, 1989;

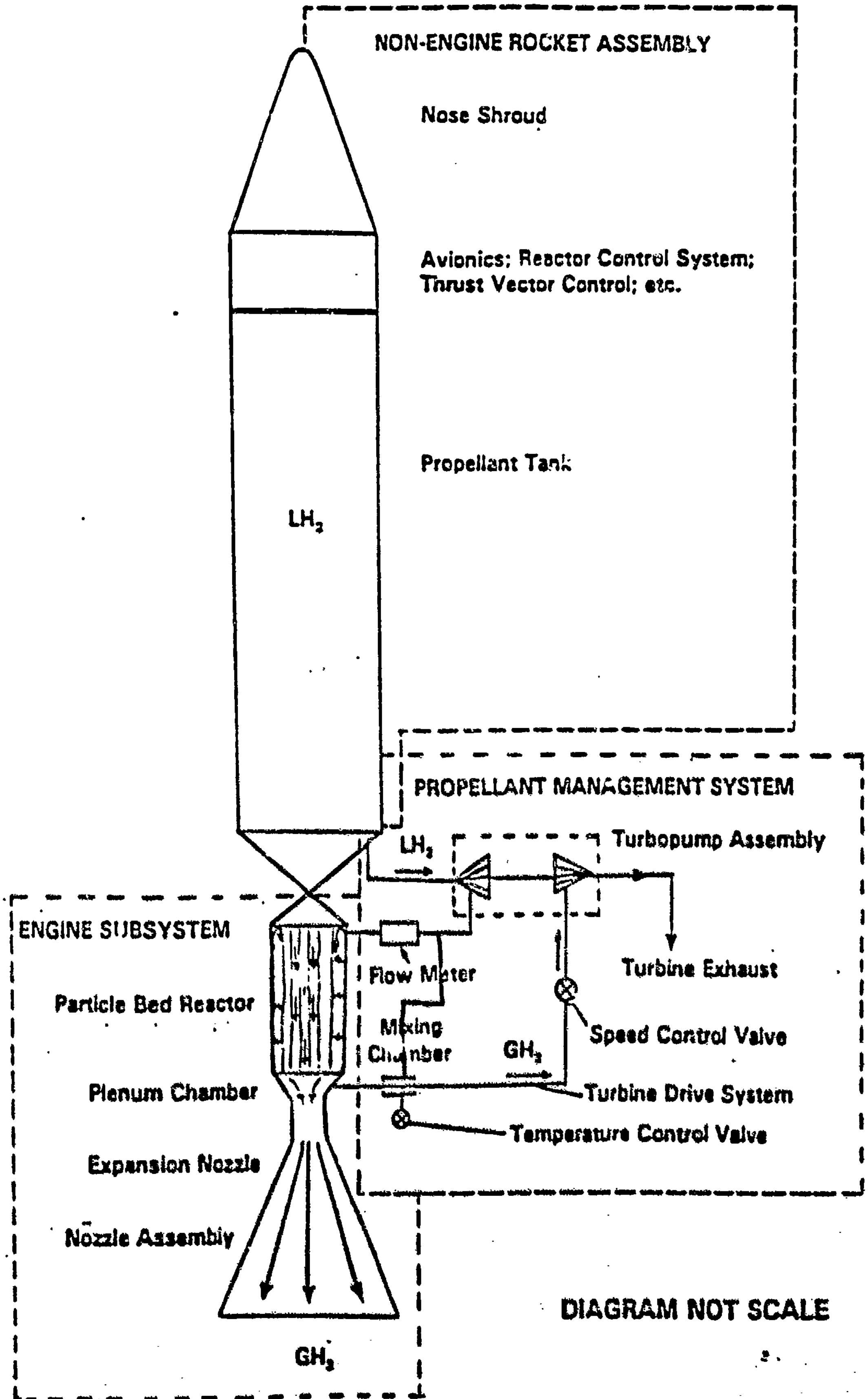

Figure 2.1-1 [redacted]
Second Stage Schematic (NOT TO SCALE)

Figure 2.1-2 [redacted]
Schedule & Milestones (U)

Ball, 1989). In the spring of 1990 a Task Force of the Defense Science Board concluded that the [redacted] design approach was technically sound, that "there is no obvious reason why all applicable safety and environmental standards should not be met", and that potential national benefits from [redacted] technology extend beyond its current application to a [redacted] (Shea, 1991).

([redacted]) The principal participants of the [redacted] program include: (1) Brookhaven National Laboratory (BNL) in Upton, NY; (2) Babcock and Wilcox (B&W) Naval Nuclear Fuel Division (NNFD) in Lynchburg, VA; (3) Sandia National Laboratories (SNL) in Albuquerque, NM; (4) Aerojet Propulsion Division of GENCORP in Sacramento, CA; (5) Hercules Aerospace Corporation in Magna, UT; (6) Garrett Fluid Systems Division (of Allied-Signal Aerospace Company) in Tempe and San Tan, AZ; (7) Airesearch Los Angeles Division (ALAD) (of Allied Signal Company) in Torrance, CA; (8) Grumman Space Electronics Division (GSED) in Bethpage, NY; (9) Raytheon Services Nevada (RSN) in Las Vegas, NV; (10) Reynolds Electrical and Engineering Company, Inc. (REECo) in Las Vegas, NV; (11) Fluor-Daniel, Inc. (FDI) in Irvine, CA; (12) the [redacted] ([redacted]) in Washington, DC; (13) the Department of Energy Headquarters (DOE) in Washington, DC; (14) Idaho National Engineering Laboratory (INEL) near Idaho Falls, ID; (15) the Nevada Test Site (NTS) near Las Vegas, NV; (16) USAF Phillips Laboratory in Albuquerque, NM; and (17) the U.S. Army Corps of Engineers - Huntsville Division (USACE-HND) in Huntsville, AL.

(U) Other potential participants include (1) Los Alamos National Laboratory (LANL) in Los Alamos, NM; (2) Marshall Space Flight Center (NASA) in Huntsville, AL; (3) Western Test Range/Western Space & Missile Center at Vandenberg Air Force Base, CA near Santa Barbara, CA; (4) Arnold Engineering Development Center in Manchester, TN; (5) UNC Manufacturing Company in Uncasville, CT; (6) and Grumman Corporation's Calverton Facility in Long Island, NY. The above is not an all inclusive list. Other participants and other locations of present participants may be identified in the future. Table 2.1-1 shows the principal participants and cooperating agencies and their respective responsibilities. Table 2.1-2 shows other potential participants.

([redacted]) The proposed action is to continue developmental research; test materials, manufacturing methods, components, and subsystems of a PBR nuclear powered rocket; and construct special facilities for ground tests involving prototypical assemblies.

2.1.3 Technology Issues (U)

([redacted]) Major technological issues and goals of the [redacted] program include the achievement and control of predicted nuclear power levels; the development of materials that can withstand the extremely high operating temperatures and hydrogen flow environments; and the reliable control of cryogenic and high temperature hydrogen propellant. Tests carried out for the program would progress systematically from initial nuclear tests and experiments to verify the PBR concept and to support the basic reactor design development; to laboratory tests of materials for reactor and nozzle components; to laboratory and field tests of reactor, nozzle, and propellant management systems assemblies; to system integration tests; and engine demonstration

TABLE 2.1-1: SUMMARY OF PROGRAM PARTICIPANTS AND COOPERATING AGENCIES (U)

NAME	LOCATION	RESPONSIBILITIES
(U) Brookhaven National Laboratory	(U) Upton, NY	(U) Reactor materials and components testing; thermal-hydraulic, and neutronic analyses; reactor design studies.
(U) Babcock & Wilcox	(U) Lynchburg, VA	(U) Reactor design testing, fabrication and assembly
(U) Sandia National Labs	(U) Albuquerque, NM	(U) Nuclear safety, nuclear instrumentation and operation, reactor control system modeling, nuclear testing
(U) Aerojet Propulsion Division	(U) Sacramento, CA	(U) Fuel element alternate materials development
(U) Hercules Aerospace Corporation	(U) Magna, UT	(U) Design and fabrication of engine lower structure and nozzle
(U) Garrett Fluid Systems Div	(U) Tempe, AZ/ San Tan, AZ	(U) Design and fabrication of attitude control system, propellant flow control system and turbopump assembly
(U) Airesearch Los Angeles Div	(U) Torrance, CA	(U) Turbine wheel testing
(U) Grumman Space Electronics Div	(U) Bethpage, NY	(U) Vehicle design and fabrication, systems integration
(U) Raytheon Services Nevada	(U) Las Vegas, NV	(U) Facility and Coolant Supply System (CSS) engineering, facility construction management
(U) Reynolds Electrical and Engineering Company, Inc.	(U) Las Vegas, NV	(U) Facility construction
(U) Fluor-Daniel, Inc.	(U) Irvine, CA	(U) Effluent Treatment System (ETS) engineering

TABLE 2.1-1: SUMMARY OF PROGRAM PARTICIPANTS AND COOPERATING AGENCIES (Con't.) (U)

NAME	LOCATION	RESPONSIBILITIES
(U) Sandia National Labs	(U) Saddle Mt Test Site or QUEST or LOFT Sites	(U) Test site preparation, planning and performance of engine ground tests, nuclear component testing
(U) [redacted]	(U) Washington, DC	(U) Program management
(U) Department of Energy		
(U) Headquarters	(U) Washington, DC	(U) Program management, nuclear safety assurance
(U) Nevada Test Site	(U) Las Vegas, NV	(U) Ground testing
(U) Idaho Natl Engr Lab	(U) Idaho Falls, ID	(U) Ground testing
(U) U.S. Air Force		
(U) Phillips Lab	(U) Albuquerque, NM	(U) Program management
(U) U.S. Army Corps of Engineers - Huntsville Division	(U) Huntsville, AL	(U) ETS engineering management

[redacted]

TABLE 2.1-2: SUMMARY OF POTENTIAL PARTICIPANTS[1] (U)

NAME	LOCATION	RESPONSIBILITIES
(U) Los Alamos National Laboratory	(U) Los Alamos, NM	(U) Fuels and material testing
(U) Marshall Space Flight Center (NASA)	(U) Huntsville, AL	(U) Material and component simulation/testing
(U) Western Test Range/Western Space & Missile Center (USAF)	(U) VAFB, CA	(U) Program review
(U) Arnold Engineering Development Center	(U) Manchester, TN	(U) Hydrogen flow testing
(U) UNC Manufacturing Company	(U) Uncasville, CT	(U) Materials manufacturing
(U) Grumman Corp - Calverton Facility	(U) Long Island, NY	(U) Hydrogen testing

[1] (U) This is not an all inclusive list. Other participants may be identified in the future.

[redacted]

and qualification tests. Upon successful completion of the ground testing, [redacted].

2.1.4 Testing Requirements (U)

(U) The development of materials, components, and assemblies for the program requires an extensive series of laboratory and field tests involving nuclear and non-nuclear materials. Most tests involve very high temperatures and pressures in potentially hazardous hydrogen environments. Each test performed would build upon the success or failure of the preceding tests. Developmental activities and testing would take place in industrial and government controlled laboratories and test sites in various parts of the U.S. These tests are described in Section 2.3.

2.1.5 Ground Test Station (U)

([redacted]) Demonstration of the [redacted] technology requires testing of reactor, nozzle, and propellent management system assemblies; system integration tests; and engine qualification tests. Because no facility exists that fully meets testing requirements, construction of a ground test facility is required. Alternative locations for a new ground test facility were considered and a summary of the Site Narrowing Report finding is provided as Appendix C. One location at the Nevada Test Site (NTS) and two locations at the Idaho National Engineering Laboratory (INEL) have been identified as reasonable alternatives for a ground test station.

2.1.6 Radiological Safety (U)

([redacted]) The basic nuclear safety philosophy of the [redacted] program is that in all phases of the program, every effort would be made to develop a safe product in a safe manner. It is stated program policy that the highest priority be given to safety and that safety concerns be adequately considered in all decisions. It is the program's objective to develop a product which can fulfill its assigned missions without undue hazards to health, safety, and the environment. Further, the developmental program (i.e., the subject of this EIS) is to be executed in such a way as to ensure maximum protection to the health and safety of the public and program workers and to protect the environment from contamination or damage as a consequence of program activities. The program would comply completely with federal, state, and local regulations or standards. These include all applicable sections of Title 10 CFR (10 CFR 20, 10 CFR 50, and 10 CFR 100) and Title 40 CFR (40 CFR 61 and 40 CFR 141); as well as DOE Orders 5400.1, 5400.5, 5480.6, and 5480.11; ANSI/ANS 15.7; and NCRP Report 91. In addition, all nuclear risks would be kept as low as reasonably achievable, considering technical, economic, societal, and other relevant factors. Programmatic and site specific safety programs are discussed in detail in Section 2.4.3.

2.2 [redacted] SYSTEM DESCRIPTION (U)

(U) This section describes the main components of the [redacted] system: the engine subsystem and the non-engine rocket assembly.

2.2.1 Engine Subsystems (U)

([redacted]) The principal engine subsystems are the Particle Bed Reactor (PBR), the Nozzle Assembly, and the Propellant Management System (PMS).

Particle Bed Reactor (U)

([redacted]) The Particle Bed Reactor consists of a core composed of [redacted] fuel elements, surrounded by a neutron moderating material.

([redacted]) Each individual fuel element (Figure 2.2-1) contains millions of fuel particles containing fissile material, [redacted]. The fuel particles are contained in the annular space between two concentric tubes enclosed in a hexagonal block of neutron moderator material. The outer tube (referred to as the cold frit) consists of a porous aluminum material. The inner tube (referred to as the hot frit) is a slotted, tapered cylinder composed of carbide coated carbon-carbon or graphite material. Top and bottom beryllium-alumina end assemblies complete the particle bed enclosure, provide positioning for the fuel element in the overall reactor assembly and comprise portions of the coolant flow distribution paths.

([redacted]) [redacted]

([redacted]) Cryogenic hydrogen (LH_2) at 25-30 K (-250 to -240° C) enters the reactor assembly at the reactor dome. Several paths provide for the movement of the hydrogen downward through the reactor. These paths are: small gaps between fuel elements, channels cut in the reflector material, the small gap between the pressure vessel wall and the reflector, and channels in the moderator material.

([redacted]) The downward flow is collected at the bottom of the core and is admitted to each fuel element at the lower end assembly. The flow moves upward into the volume between the moderator and cold frit, then radially inward through the cold frit and across the particle bed where it is heated to approximately 3000 K (2730° C), and finally through the hot frit into a central open region. The hot exit gas from each element flows downward and collectively enters the nozzle plenum at a flow rate of approximately 20 kg/sec (50 lbs/sec). A small portion of the hot gas is bled off into a mixing chamber for use in the turbopump drive system. The

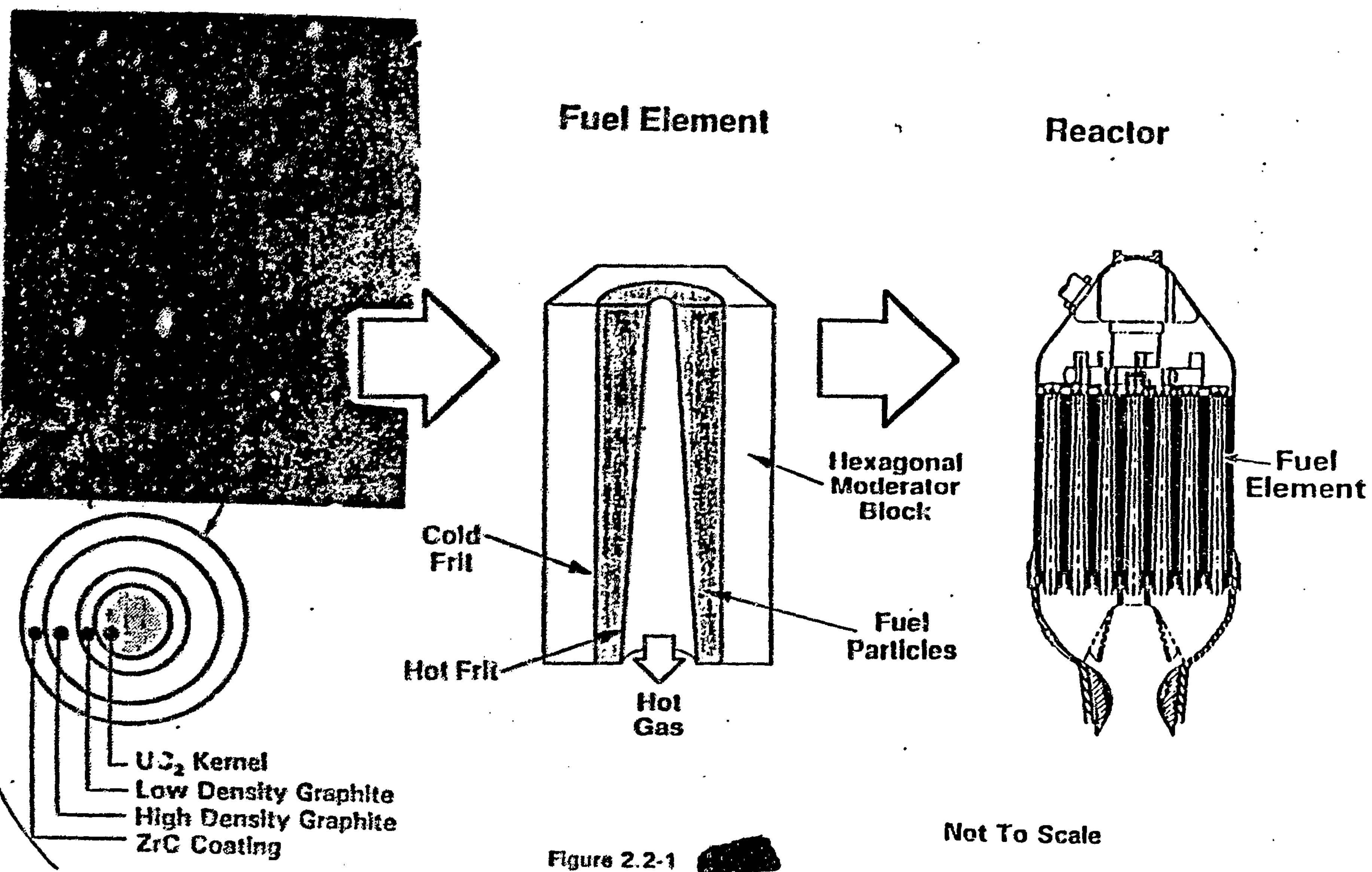

Figure 2.2-1 [redacted]
ENABLING TECHNOLOGY

remainder is directed to the nozzle throat, where it is expanded for propulsion. The system as described here could generate a power level of 2000 megawatts (MW).

([redacted]) The principal technology issues and goals related to the engine are (1) verification of the PBR concept; (2) design and fabrication of fuel particles that would have sufficiently high melting points; (3) design and fabrication of the "hot" frits to withstand high temperatures and not react adversely to the fuel particles or to the flow of coolant; (4) design and fabrication of the engine nozzle to withstand the high temperatures and not react adversely to the propellant; (5) design of the cold frits to distribute coolant and match flow to power; and (6) design of a reliable reactor control system.

([redacted]) Babcock & Wilcox (B&W) has the principal responsibility for designing and fabricating the Particle Bed Reactor components; assembling the various reactors used in the systems tests; specifying the requirements associated with conducting special nuclear tests; and fabricating and characterizing the nuclear fuel particles.

<u>Pressure Vessel/Nozzle Assembly</u> (U)

([redacted]) The Pressure Vessel/Nozzle Assembly would perform the following two tasks: (1) provide pressure containment and support for the PBR, and (2) collect hydrogen gas from each reactor fuel element and accelerate the gases through the throat section of the expansion ratio nozzle skirt to generate thrust. The nozzle throat would be coated with a refractory material to minimize erosion.

([redacted]) A diagram of the nozzle [redacted] and its interface with the reactor is shown in Figure 2.2-2. The nozzle section terminated by the dotted line is referred to as the "cut-back" nozzle, and represents the configuration which would be used for ground based nozzle testing. The cut-back nozzle would provide prototypical back pressures to the reactor and would best simulate space conditions. (Testing of the full nozzle in non-vacuum conditions would result in unrepresentative, and possibly destructive pressure loadings, and would produce invalid test results.)

<u>Propellant Management System</u> (U)

(U) The Propellant Management System (PMS) was shown in Figure 2.1-1. Its purpose is to provide controlled flow and pressure to the engine and ancillary subsystem. The system consists of the tank isolation valves, pump discharge valve, flowmeter, temperature control valve, mixing chamber, speed control valve and turbopump assembly. The system contains provisions for tank pressurization and chilldown/conditioning of cryogenic fluid paths as well as for supplying the hot hydrogen working fluid to the thrust vector control actuators or the turbopump assembly.

([redacted]) During operation, LH_2 [redacted] exits the propellant tank, flows through a tank isolation valve and enters the pump section of the turbopump assembly. The pump raises the pressure and temperature of the LH_2 to [redacted] respectively. After exiting the pump, the propellant is delivered to the reactor where it is heated to the design temperature of [redacted].

[redacted]

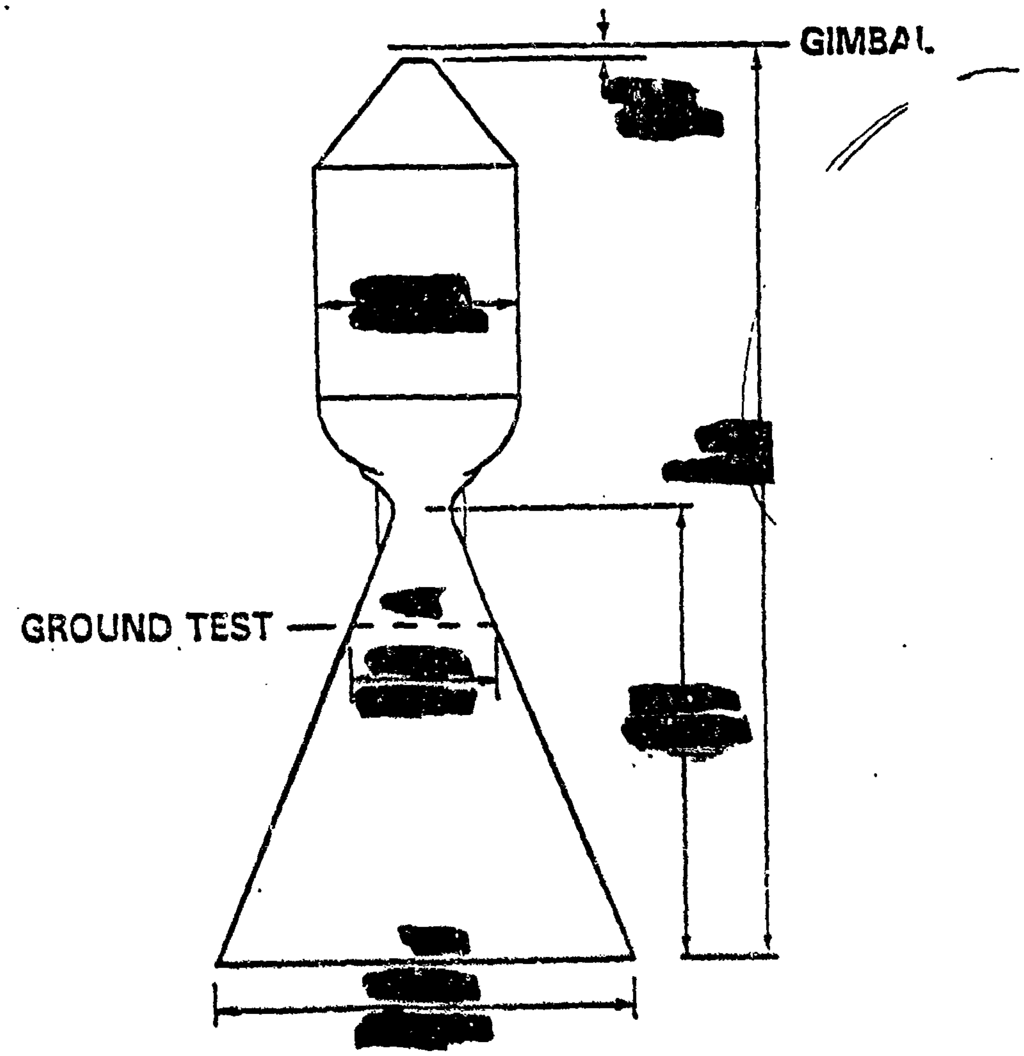

Figure 2.2-2 (U)

NOZZLE ASSEMBLY (U)

[redacted]

2.2.2 Non-Engine Rocket Assembly (U)

(U) The non-engine rocket assembly consists of the propellant tank, the equipment bay, and the nose shroud. [redacted]

(U) The approximately [redacted].

2.3 [redacted] TEST PROGRAM (U)

(U) This section describes material and component development, fabrication and assembly of the components, construction of the facilities and ground testing. [redacted]. The testing program is designed to validate each component before preceding to the subassembly level and to validate each subassembly before proceeding to the assembly level. A high level of confidence will be achieved at each phase of testing before preceding to increasing levels of complexity. (Section 2.3.3 describes the philosophy of the ground test program.)

(U) The testing process is also designed to minimize radiation exposure to the environment. A major goal of the program will be to develop particle coatings that will minimize losses of fission products during testing.

(U) The conceptual flow diagram of the [redacted] development program is shown in Figure 2.3-1.

2.3.1 Materials and Component Development and Testing (U)

([redacted]) Material and component development for the [redacted] program is a lengthy process in which many firms and organizations would participate. Fabrication and assembly of the [redacted] components is anticipated to take place at many sites. The principal participants in the fabrication and assembly process include: (1) Brookhaven National Laboratory (BNL) in Upton, NY; (2) Babcock and Wilcox (B&W) Naval Nuclear Fuel Division (NNFD) in Lynchburg, VA; (3) Sandia National Laboratories (SNL) in Albuquerque, NM; (4) Aerojet Propulsion Division of GENCORP in Sacramento, CA; (5) Hercules Aerospace Corporation in Magna, UT; (6) Garrett Fluid Systems Division (of Allied-Signal Aerospace Company) in Tempe and San Tan, AZ; (7) Air-Research Los Angeles Division (ALAD) (of Allied Signal Company) in Torrance, CA; and (8) Grumman Space Electronics Division in Bethpage, NY.

(U) Some of the materials tests have already taken place but are included in this Description of Proposed Actions so that the decision maker can gain a full understanding and appreciation of the research and development that have led to the proposed actions. Tests that have already been performed are so noted.

2.3.1.1 General Material Tests (U)

(U) The material development and testing are described below:

<u>Hydrogen Erosion Test</u> (U)

([redacted]) The hydrogen erosion test would be conducted at Garrett's facility in San Tan, AZ. This test determines the resistance of hot frit candidate materials to hydrogen erosion. The experiment also supports the development of particle coating materials and investigates the compatibility of candidate coating and frit materials. These tests involve flowing gaseous H_2

[redacted]

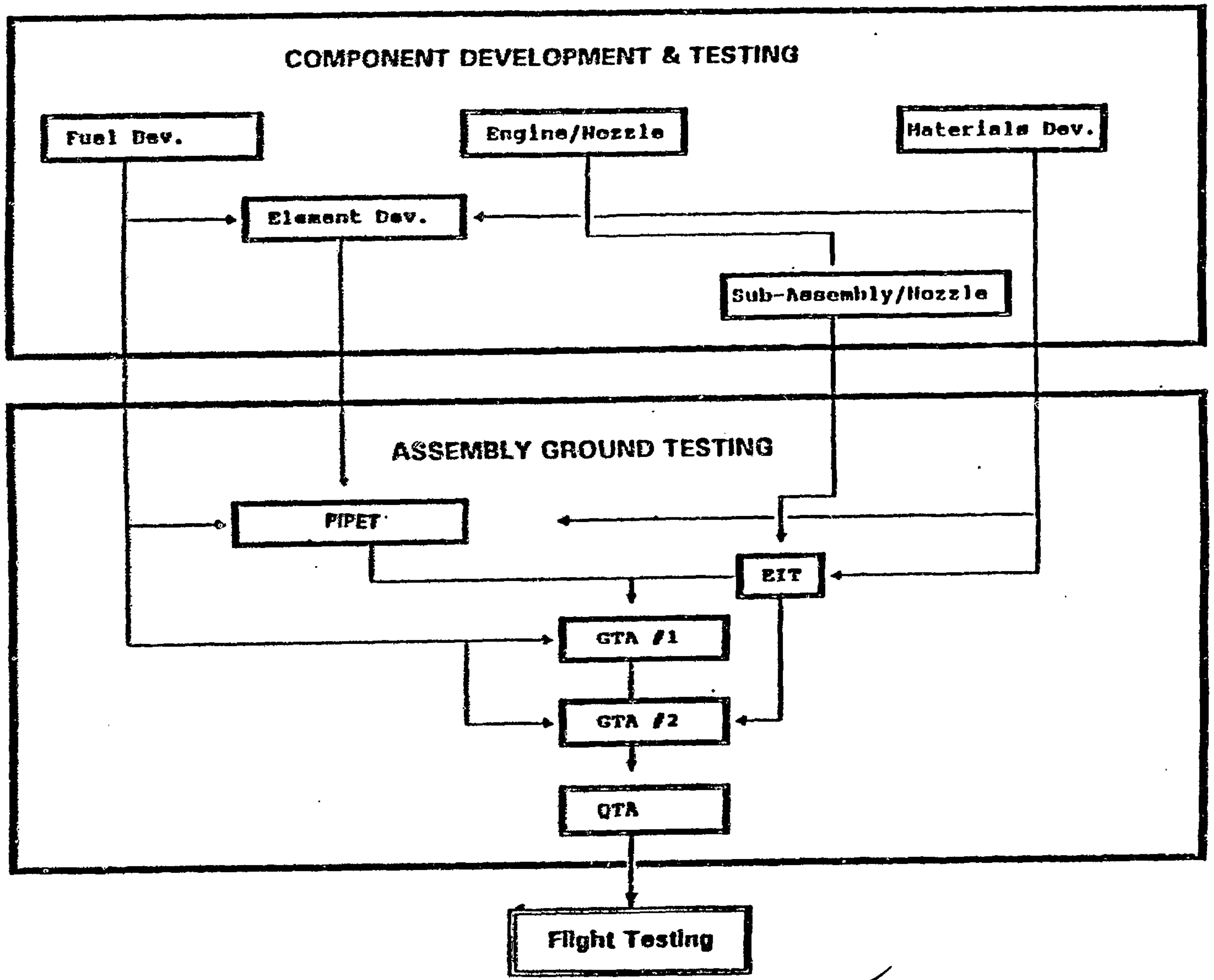

Figure 2.3-1 [redacted]

DEVELOPMENT PROGRAM FLOW DIAGRAM (U)

[redacted]

over samples heated in an induction furnace. Waste products from this experiment include gaseous H_2 and Ar and small chips of carbon/carbon and graphite.

Materials Compatibility Test (U)

([redacted]) The materials compatibility tests are being performed principally at BNL with additional tests being performed at B&W and Garrett. The tests determine chemical compatibility among various materials in a hot hydrogen environment. In these tests, graphite components are heated in a stainless steel vessel and are subjected to high temperature hydrogen gas [redacted]. Helium gas at 350 kPa (50 psi) is used for purging. Waste products include small volumes of gaseous H_2 and He and a small amount of evaporated alcohol and acetone. Zirconium oxide and boron nitride are used as insulating materials in these experiments.

Chemical Processes Testing (U)

([redacted]) Chemical processes testing would take place principally at B&W with additional tests to be conducted at BNL. This testing involves heating graphite samples impregnated variously with uranyl nitrate, uranium oxide, and uranium carbide in nitrogen, argon, and hydrogen environments [redacted]. Waste products from these tests include the impregnated graphite, hydrogen gas and several micrograms of natural uranium per month. All the uranium-bearing materials are toxic.

2.3.1.2 Nozzle Material Tests (U)

([redacted]) Engine nozzle development and fabrication is taking place at Hercules Aerospace Corporation. The goal of the program is to develop a material which is lightweight, operates in the appropriate design temperature range of [redacted], and is hydrogen compatible and erosion resistant.

(U) The engine nozzle is fabricated as a single piece carbon-carbon composite structure. The structure is formed from a woven carbon fiber pre-form which is then reinforced with a carbon matrix.

(U) Three types of nozzle material testing would be performed at the coupon level. These are identified as materials properties tests, materials compatibility (corrosion) tests, and material erosion tests. The temperatures and flow rates achieved in the coupon tests are below those expected in the full scale operation, but are considered sufficient to properly characterize the materials selected; full-scale materials will behave in the prototype in a similar manner as the coupons will behave in these tests. Each type of test is described briefly below:

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[1](U) These are prototypic testing temperatures and pressures.

1) Materials Properties Tests (U)

(U) Material properties tests to provide information to support design tasks and to verify safety margins would take place primarily at B&W with support provided by BNL. Test specimens machined from carbon-carbon billets are conditioned to a prescribed temperature in an inert (nitrogen) atmosphere and tested per standard methods. Procedures include testing for tensile, compressive, and shear strengths; and thermal expansion; conductivity; and diffusivity. The waste consists of scrap pieces of carbon-carbon. No hazardous wastes would be generated by the materials properties tests.

2) Materials Compatibility (Corrosion) Tests (U)

([redacted]) Materials compatibility tests, which are taking place at the hot gas flow test facility at BNL, evaluate the corrosion resistance of candidate coated carbon-carbon materials to hot flowing H_2 gas. [redacted] gas at standard flow rates [redacted], temperatures [redacted], and volumes [redacted] would flow across the samples. Post test measurements of the samples would be conducted following exposure to determine coating and carbon-carbon mass loss.

3) Materials Erosion Tests (U)

(U) Materials erosion tests, would take place at Garrett's hot gas flow test facility at San Tan to evaluate the erosion resistance of candidate carbon-carbon materials and coatings to hot flowing H_2 gas. Hot H_2 gas (at similar flow rates and temperatures as used for the corrosion tests discussed above) would flow across sample surfaces. Post test measurements of the samples would be conducted following exposure to determine coating and carbon-carbon mass loss.

2.3.1.3 Fuel Development (U)

([redacted]) The development of refractory materials and coatings for fuel particles, which are subject to extremely high temperatures and possible hydrogen erosion, are some of the major technology goals of the program. As discussed in Section 2.2.1, the fuel particles consist either of a central kernel of fissile material surrounded by one or more carbon layers and an outer coating of a non-fissile refractory carbide [redacted].

(U) Work presently taking place at BNL is aimed at determining properties, characteristics, performance, and compatibility of candidate materials under reference temperatures and pressures as well as their reactivity with hot hydrogen gas. The experiments at BNL are carried out in existing facilities using existing equipment such as resistance furnaces, induction furnaces, and gas-flow furnaces.

(U) Work at Babcock and Wilcox is aimed at synthesizing the kernels. The processes and equipment are present at B&W and can be adapted to future variations in kernel constituents with modification to the process and equipment. Any of the future variations in kernel constituents

will have been developed in the laboratory through pilot plant levels prior to introduction into the production line. Thus, none of the processes or equipment used or anticipated to be used in the synthesis of the kernels fall into the category of new development. The processes and waste products generated will be a part of the in-place control system that is anticipated to easily accommodate this activity.

([redacted]) Some facility modification was required to complete fuel manufacturing activities in support of the [redacted] Program. The modification included the installation of two bed furnaces, ventilated enclosures, and various process improvement and quality control equipment (B&W, 1988). [redacted].

([redacted]) B&W's past experience in nuclear fuel fabrication using similar materials and processes would be the foundation for developing fuel particle fabrication methods for the Particle Bed Reactor. B&W would develop processes for application of high temperature coatings on graphite and subsequent thermomechanical and thermochemical testing to assure the desired performance at reference temperatures. These would be non-nuclear heating tests to measure chemical effects and mechanical properties as a function of temperature for different coating processes. Based on test results, the optimum coating composition, and coating process would be selected. [redacted].

([redacted]) The quantities of low-level radiological waste that would be generated by [redacted] activities are estimated to be less than one kilogram (2.2 lbs) per month for about 4-5 years. Small quantities of mixed wastes [i.e. trichloroethylene (TCE)] would also be generated. B&W has all the applicable permits required to conduct operations in support of the [redacted] program. No additional personnel, facilities, or equipment are required to conduct operations at B&W.

(U) Potential processes for fabricating fuel particles include a gelation process; a diffusion process; [redacted]. These are described below:

Gelation Process (U)

([redacted]) The B&W internal gelation process uses a partially hydrolyzed mixture of uranyl nitrate solution mixed with concentrated hexamethylenetetramine (HMTA) to form a broth that is dispersed as droplets into a hot immiscible carrier liquid in which the gelation occurs. Heat initiates the gelation reaction which releases ammonia by decomposing the HMTA homogeneously and rapidly throughout the droplet. The metal precipitates as oxides on the spheres, which are then separated from the carrier liquid and washed in an ammonium hydroxide solution to remove the byproducts of the reaction. Following washing and drying, a stream of heat treatments are used to convert the "green" kernels to sintered kernels of the proper size and density. For carbide formation, B&W combines highly dispersed carbon with the uranyl nitrates and converts the oxides to carbides in a high temperature carbothermic conversion preceding the sintering phase of the furnace processes.

(U) Hexamethylenetetramine has been identified as a slight health, flammability, reactivity and contact hazard (primarily as a skin and eye irritant), however, B&W has the appropriate storing and handling procedures to preclude any impacts on safety. In addition, B&W has appropriate storage and handling procedures to preclude any impacts on safety for uranyl nitrate, identified as a radioactive material according to Department of Transportation (DOT) hazard classification.

Diffusion Process (U)

([redacted]) The diffusion method utilizes a zirconium carbide (ZrC) coated uranium carbide (UC) sphere. This method involves applying very thin layers (flash coatings) of carbon and zirconium metal to an uranium carbide sphere using a chemical vapor deposition technique. The particles are then overcoated with zirconium carbide using standard technology already in use at B&W. The resultant "kernel" is then heat treated to induce inter-diffusion of the heterogeneous layers into a homogenous kernel.

[redacted]

([redacted]) [redacted].

2.3.1.4 Hydrogen Blowdown Tests (U)

([redacted]) Hydrogen blowdown tests are being performed at BNL. These tests obtain data on fluid mechanics and heat transfer in a simulated PBR. In these tests, simulated non-nuclear fuel elements of zirconium oxide are heated to 2070 K (1800° C) and then subjected briefly to H_2 flow at 7 MPa (1000 psi) and 2270 K (2000° C) and allowed to blow-down. The hydrogen blowdown tests use the lowest temperatures and pressures possible that will allow validation of the numerical models. The experimental apparatus consists of a pressure vessel, heater, and coolant storage vessel located in a concrete walled enclosure. Gaseous waste products, including approximately 2 kg (4.4 lbs) of hydrogen per test, and lesser amounts of helium and nitrogen are exhausted to the atmosphere.

2.3.1.5 Particle Nuclear Tests (PNT) (U)

([redacted]) The Particle Nuclear Tests (PNT) are taking place at Sandia National Laboratory (SNL). The tests are a series of in-reactor tests to determine candidate PBR fuel particle behavior performance limits and failure mechanisms when subjected to nuclear heating for different times, temperatures and power levels. This information would be used to improve fabrication techniques, qualify fuel for additional testing, and determine limited safety related information such as size of debris and fission product release resulting from particle failure. (Particle failure is defined as the point when the particle fully releases its fission products).

([redacted]) The tests consist of the irradiation of small crucibles of fuel in an aluminum capsule in the Annular Core Research Reactor (ACRR) at Sandia. The fuel particles for each test have a total mass of 14 grams (0.5 oz) of uranium carbide of which 5.6 grams (0.2 oz) is fully enriched uranium. Two to four tests occur each year, [redacted]. The test capsule is filled with a mixture of 4% hydrogen gas and 96% inert gas (argon or helium). The particles are irradiated up to 10 times in each test, after which they are removed and examined. The radioactive waste products would be disposed of in accordance with SNL's existing waste program. Estimated radioactive waste products generated during the PNT are shown in Table 2.3-1.

2.3.1.6 Critical Experiment (CX) (U)

([redacted]) The critical experiments, which were initiated by Sandia and are continuing at the Sandia Pulsed Reactor (SPR) Facility, provide experimental verification of neutronic computer codes and allow measurements of parameters which could not be resolved using computer modeling techniques. The major components of the CX are the assembly structure, fuel, and moderator. The quantity of waste products produced are 1,140 liters (300 gal) of deionized water, 5 grams (0.2 oz) of boron, 6 liters (1.6 gal) of solvents, 6 liters (1.6 gal) of manitol, and 5 grams (0.2 oz) of boric acid, and 200 liters (55 gal) of anti-contamination clothing. A NESHAP permit is not required since the CX tests do not produce any new radionuclides.

2.3.1.7 Fuel Element Nuclear Tests (U)

([redacted]) Fuel element development nuclear tests include both component and operational testing of PBR fuel elements. Component tests include Pulsed Irradiation Particle Element (PIPE) tests and Nuclear Element Tests (NET). These are done with external sources of radiation by inserting a fuel element in existing test reactors. These tests are described below:

2.3.1.7.1 Pulsed Irradiation Particle Element (PIPE) Tests (U)

([redacted]) The PIPE tests were carried out to verify the basic PBR concept by investigating the performance of single fuel elements at moderate temperatures [redacted] and power densities using gaseous hydrogen coolant. The tests, recently completed in the ACRR at Sandia National Laboratories, provided data on both flow and thermal conditions of cold and hot frits and design data for the fuel elements.

2.3.1.7.2 Nuclear Element Tests (NET) (U)

([redacted]) The Nuclear Element Test (NET) series consists of fuel element qualification tests carried out using the ACRR at Sandia National Laboratories. Two to four tests are planned per year over a two to three year period starting in 1991. The purpose of these tests is to demonstrate the integrity and performance of PBR fuel element designs under conditions of high temperature and moderate hydrogen flow. The test series would begin at low temperature with subsequent tests approaching [redacted]. During each test, a single fuel element would be repeatedly irradiated for up to 40 second periods in the ACRR. Waste production generated during the NET may include both mixed waste and radioactive waste.

[redacted]

TABLE 2.3-1
ESTIMATED RADIOACTIVE WASTE
FROM PARTICLE NUCLEAR TESTS (U)

Products	Quantity (kg/yr)	Type
Aluminum	50	Radioactive
Polyethylene	50	Radioactive
SS-304/316	50	Radioactive
Tungsten	0.1	Radioactive
Uranium-235	0.015	Radioactive
Xenon/Krypton (gas)	<0.01 Ci/yr	Radioactive
Zirconium Carbide	0.1	Radioactive
Other[1]		

[1](U) Other wastes include 5.3 ft^3 (0.2 m^3) of Argon, 0.22 ft^3 of H_2 (6,200 cm^3), and small quantities of contaminated glass, alcohol, gloves, paper and cloth.

[redacted]

These wastes would be disposed of in accordance with SNL's existing policies. Estimated annual quantities (based on performing four NET tests) of such waste are listed in Table 2.3-2.

2.3.1.8 Propellant Management System Testing (U)

(U) Most of the testing of the components of the Propellant Management System would be performed at Garrett Fluid Systems Division's Tempe facility. Spin testing of the turbine wheel would be performed at existing test cells at the Air-Research Los Angeles Division (ALAD), Allied Signal Company in Torrance, CA.

2.3.1.8.1 Turbopump Assembly Testing (U)

(U) The objective of the turbopump assembly testing is to measure the pumping performance of the turbopump assembly when the pump is supplied with a source of either inert fluids or cryogenic hydrogen. The testing consists of warm air and steam testing of the turbine wheel, and cold spin testing of the rotating assembly using a bladeless turbine wheel. All waste hydrogen generated by the tests would be burned in a flare stack that is vented to the atmosphere.

<u>Pump Tests</u> (U)

(U) The pump would be integrated into a standard pump test cell and driven by an electric motor or an air turbine motor. The test would be conducted using approximately 37,000 liters (10,000 gal) of water or liquid nitrogen as the working fluid. The pumps would be driven at various speeds and relevant performance data recorded. Useful pump data would be generated during component testing using these inert fluids in place of cryogenic hydrogen.

<u>Turbine Test</u> (U)

(U) The turbine shaft would be coupled to a dynamometer to measure load at various speeds under various pressure and temperature conditions. The turbopump assembly would then be installed in a test rig that would allow measurement of pump fluid flow rates, pump pressures, pump temperatures and pump shaft speed while pumping cryogenic hydrogen. The hot-hydrogen flow rate would be determined while maintaining operating temperature and pressure at the inlet of the turbine to satisfy an operating speed condition. Approximately 56,700 liters (15,000 gal) of liquid hydrogen would be consumed in less than one hour.

2.3.1.8.2 Hot-Hydrogen Gas Generator Testing (U)

(U) Garrett is responsible for the hot-hydrogen gas testing. An existing hot-hydrogen gas generator would be used to demonstrate the feasibility of generating a stream of hot hydrogen with a heat exchanger mechanism. A scaled model of the hot-hydrogen gas generator required to drive the turbopump assembly would be tested with pressurized hydrogen and oxygen. Temperatures, pressures and flow rates would be measured to determine the effectiveness of the combustor and the heat exchanger (Garrett, 1991).

TABLE 2.3-2
ESTIMATED RADIOACTIVE WASTE
FROM NUCLEAR ELEMENT TESTS (U)

Products	Quantity (kg/yr)	Type
Aluminum	100	Radioactive
Beryllium	55	Mixed Waste[1]
Molybdenum	150	Radioactive
Polyethylene	50	Radioactive
SS-304/316	100	Radioactive
Tungsten	1.0	Radioactive
Uranium-235	1.0	Radioactive
Xenon/Krypton (gas)	<0.1 Ci/yr	Radioactive
Zirconium Carbide	4.0	Radioactive
Other[2]		

[1](U) Mixed wasted would be generated if beryllium is oxidized or comes in contact with other hazardous materials.

[2](U) Other wastes include hydrogen, nitrogen and helium gases, contaminated solvents, epoxies, paper, and cloth.

(U) Approximately 1900 liters (500 gallons) of cryogenic hydrogen and oxygen could be consumed in less than one hour. All waste hydrogen generated by the tests would be burned in a flare stack that is vented to the atmosphere. The burning of hydrogen is not regulated under the Clean Air Act.

2.3.1.8.3 Valve Components Testing (U)

(U) The objective of this testing is to demonstrate the integrity and operational accuracy of the speed control valve and the temperature valve control actuator. The flow of hot-hydrogen gas would be passed through the components while it is operated over its control flow range. Approximately 110 kg (250 lbs) of hydrogen would be burned in a flare stack and vented to the atmosphere during each test.

2.3.1.8.4 Cryogenic Component Testing (U)

(U) Development tests would be conducted on the cryogenic components which include valves and a flow meter to determine their performance in a cryogenic hydrogen environment.

(U) The valves would be installed in a test rig that would allow the measurement of port leakage, external leakage, opening rate, pressure drop, and closing rate. The flow meter would be installed in a test rig that would allow the measurement of flow accuracy, pressure drop and response time. Approximately 37,800 liters (10,000 gal) of cryogenic hydrogen would be consumed in less than one hour. The waste hydrogen would be burned in a flare stack and vented to the atmosphere.

2.3.2 Fabrication and Assembly (U)

(U) This section describes the fabrication and assembly of the following components: the fuel elements, the reactor and reactor control system, and the Propellant Management System. This section also describes the system ground test article assembly.

2.3.2.1 Components and Assemblies (U)

2.3.2.1.1 Fuel Element Assembly (U)

([redacted]) The fuel elements are assembled by loading the fuel particles into the annulus between the hot frit and the cold frit liner. This is done with a fuel particle loading device. This device would hold the element subassembly, expand the cold frit liner and homogeneously load the fuel particles to a nominal packing fraction. The bed is vibrated to ensure uniform packing. The hot frit/bed/liner assembly is placed into the cold frit and an end flange is welded to the cold frit. Following a final visual and dimensional inspection, the fuel element is either loaded into the shipping container for transportation to the ground test station for assembly or is installed in the assembly to be tested.

2.3.2.1.2 Reactor Assembly (U)

([redacted]) In general, the reactors to be used in ground testing are assembled in the following sequence: First, the control devices are mounted on a locator grid plate and this plate is inserted into the reactor vessel. Then all of the power and control leads are passed through the vessel wall. The fuel modules are then installed among the control devices. The hot channel of each element contains a neutron poison material. The seal plate is placed over the modules and each one is welded to the seal plate. The support structure and converging nozzle section are then added and the nozzle section is attached to the reactor vessel. A neutron monitor would be used to ensure sub-criticality during assembly.

(U) The appropriate external equipment such as the mixer and turbopump is then attached to the vessel, partially completing the engine assembly.

2.3.2.1.3 Reactor Control System Development (U)

([redacted]) SNL, BNL and B&W would be responsible for formulating control algorithms for the reactor. Grumman and Garrett would provide control algorithms for the propellant management system. Grumman would integrate all of these algorithms, and provide the interface to the control devices and sensors, and verify performance of the Integrated Control System (ICS). The integration and verification activities would consist of software development validation. For safety reasons, these simulations would not include use of radioactive materials or hydrogen. The activities would be accomplished at Grumman Space Electronics Division in Bethpage, NY.

2.3.2.1.4 Propellant Management System (U)

(U) Garrett, has chief responsibility for the design and fabrication of the propellant flow control system and the turbopump assembly. Except for the turbopump assembly, and perhaps the mixer, the propellant management system is primarily comprised of conventional aerospace components, which would be fabricated and assembled using conventional aerospace industry processes and procedures. These processes and procedures include forging, machining, and welding.

2.3.2.1.5 Test Article Assembly (U)

(U) All individual reactor fuel element assemblies or reactors would be fully prepared at B&W's facility prior to shipment to the ground test station. The current test station design does not include facilities to accommodate reactor fuel element assembly.

(U) The reactor manufacturer would prepare these elements as necessary to ensure incident free transportation from their facility to the ground test station. All shipments of elements would be accomplished in suitable over-the-road shipping containers in accordance with Department of Transportation (DOT) regulations 49 CFR 170-179[2]. Upon arrival at the ground testing location, the components would be inspected and any necessary assembly performed to provide

[2](U) See Section 2.4.2 for discussion of programmatic transportation issues

a complete test article which would then be transferred to the designated test cell for installation, testing, and operations.

(U) Assembly activities would include all necessary quality control activities as specified by the reactor manufacturer. These activities, to be performed by ground testing personnel, would be monitored as necessary. Oversight requirements which are specified by the reactor manufacturer may be augmented as deemed appropriate by safety review committees and/or test station operational supervision.

(U) In the event that the Safety Analysis Report (SAR) safety analysis can not support shipment of a complete reactor assembly (with fuel elements), the above procedure would be modified to provide for assembly at the ground test station. Modification to include reactor assembly capability would require design, construction and operating changes to the ground test facility.

(U) The Preliminary Safety Analysis Report (PSAR) will be available in early 1992. Conceptual evaluations indicate that PIPET assemblies can be shipped and that it is likely (based on nuclear navy experience) that the GTA and QTA SARs will show that assembled reactors can be shipped intact.

2.3.2.2 Element/Reactor/Engine Ground Test Facilities (U)

(U) This section describes the facilities for assembling and testing the components for the element/reactor/engine nuclear testing on the ground. (The alternative locations for these facilities are described in Section 2.5).

([redacted]) Construction of new facilities would be phased to initially provide a sub-scale facility to accommodate the initial ground testing. Sub-scale tests would include less than 50 tests over a period of three or four years. Approximately five tests would be run on each set of fuel elements to be tested. These tests would include some deliberate tests to failure of the fuel and fuel elements to characterize failure mechanisms and margins.

([redacted]) The sub-scale facility would be expanded later to provide the full-scale facility necessary to complete the proposed activities in support of the program. The expanded full-scale test facility would be added to perform the subsequent ground tests based on the results of the test series performed at the sub-scale facility. The ground test facility would be designed to accommodate an engine with a capacity of 2,000 MW. It is estimated that about five full-scale test series would be run. Each series may have one to five tests.

2.3.2.2.1 Ground Test Facility Description (U)

(U) The ground test facility would be constructed in two phases. The sub-scale facility would include a single test cell for the fuel element test reactor as well as the supporting infrastructure. Upon satisfactory completion of tests conducted at the sub-scale facility, the test station would be expanded to the full-scale facility. A detailed account of the tests to be performed at the sub- and full-scale facilities are described in Section 2.3.3.

(U) Construction of the sub- and full-scale ground test facilities is expected to require an approximately 18 month period each, with an average work force of about 35 and a peak work force of about 100. The number of personnel on site during pre-operational activities at the sub-scale facility would be limited to approximately 30 security, technical, administrative, and maintenance personnel. The pre-operational staff of the full-scale facility would be approximately 50-60. During actual testing operations for both the sub-scale and full-scale facilities, the number of personnel on site would be reduced to no more than five.

2.3.2.2.1.1 Sub-Scale Facility (U)

(U) The conceptual design of the sub-scale facility is shown in Figure 2.3-2. The facility would include a control bunker, data acquisition and instrumentation/control systems, a receiving and assembly building, a test cell, a coolant supply system, an effluent treatment system (ETS), a remote inspection and maintenance system, roads and services, and safeguards and physical security. The major features of the sub-scale facility are discussed in detail below:

Control Bunker (U)

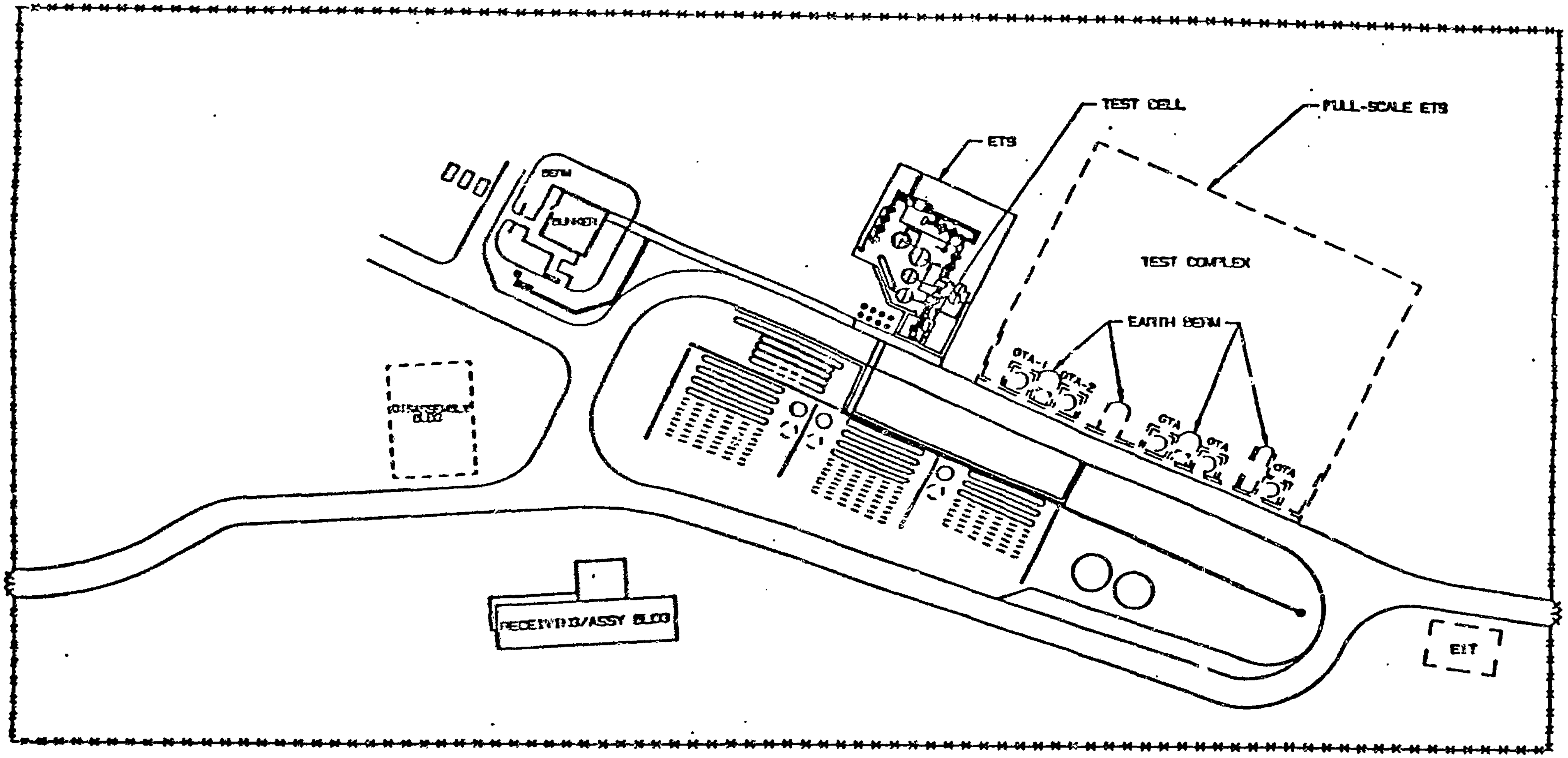
(U) The control bunker would be an earth covered reinforced concrete building from which access to the test station, activities involving the test cell, and a system to provide video surveillance over the entire test station would be controlled. The bunker would contain all control consoles associated with the test facility (SNL, 1990a).

([redacted]) Additional facilities would be required to accommodate the heating, ventilation and air conditioning systems, and nuclear grade filtration trains required to enhance control room habitability and mitigate abnormal reactor operating conditions. Specifications for the design of nuclear filtration equipment sufficient to ensure control room habitability during both normal and abnormal operating conditions would be developed subsequent of the results of the safety analysis reports associated with the sub-scale test reactor. The bunker would be covered with an approximately 0.5-m (2-ft) deep earth cover to provide adequate protection from normal operating radiation fluxes and an improbable but hypothesized severe accident scenario involving the sub-scale test reactor (SNL, 1990a).

(U) The fire protection system for the control bunker would be designed in accordance with DOE/EP-0108, Standard for Fire Protection of DOE Electronic Computer/Data Processing Systems; Group 2 Ordinary Hazard Occupancy classification; and National Fire Protection Association (NFPA) Standard 13. These codes and regulations specify all aspects of design which affect fire safety at the ground test facility (SNL, 1990a).

Data Acquisition and Instrumentation/Control Systems (U)

(U) Data Acquisition System. To support the data acquisition and storage needs for sub-scale facility testing, a high performance data acquisition system would be required. The equipment would be located either within the control bunker or on reinforced concrete pads external to the control bunker (SNL, 1990a).



KEY
Full-Scale Facility --------

GRADING PLAN
SCALE: 1" = 50'

GRAPHIC SCALE
0 50 100 150 FT
1" = 50'

Figure 2.3-2

(U) Instrumentation System. Pressure, flow, temperature, and neutron flux levels are the primary control and diagnostic indications required to meet the requirements of both the sub-scale and full-scale experiments. Temperature would be monitored with thermocouples. Pressures would be measured by pressure taps and conducting tubes connected to strain gauge transducers. Flows would be directly measured by turbine flow meters, calibrated for the various fluids required for each test system. Neutron flux would be monitored by fission chambers and self-powered neutron detectors. Leak detection is also necessary for fluid supply systems. All signal conditioning and amplification would be performed in areas within or near the test cell with each area adequately shielded from the test article (SNL, 1990a).

(U) Control System. The control system provides the required safety and control functions for all operations at the test facility. The system consists of sensors, electronics, actuators, and displays necessary for remote control of all functions associated with the test systems. In addition, the control system provides visual indication of critical system parameters and process status to assure safe operation during all phases of the experimental programs (SNL, 1990a).

(U) To prevent an accident from inflicting personal injury or equipment damage, some of the proposed procedures are to:

1) Locate the control bunker in an area so that in emergencies all critical equipment can be safely operated by operating personnel as required.

2) Provide for an automatic shutdown that would be initiated if a critical out-of-range condition is detected.

3) Ensure that remotely controlled components/equipment would move to their fail safe position (e.g., by spring action) if operational power is lost (SNL, 1990a).

Receiving and Assembly Building (U)

(U) A receiving and assembly building is required at the test site. In this building, the components of the reactor to be tested at the sub-scale level would be assembled and non-nuclear testing conducted prior to their being transported to the test cell. Sufficient space would be provided within this building for the normal administrative requirements associated with these activities (SNL, 1990a).

([redacted]) As conceptualized, the assembly bay contains work areas for assembling the sub-scale test reactor components and associated instrumentation, as well as areas for operating the Remote Inspection and Maintenance System (RIMS). These same areas may also be used for checking the future engine components and reactors upon arrival and prior to installation in the test cells. A storage vault is required within the assembly building to store the sub-scale test reactor fuel elements and canister assemblies, which contain less than 50 kg (110 lb) of Category III quantities of Special Nuclear Material (SNM) (SNL, 1990a).

Test Cell (U)

(U) The sub-scale facility would include a test cell to accommodate the initial ground tests (SNL, 1990b). The sub-scale test cell would be an approximately 7- to 8-m (25-ft) deep, 30- to 40-m^2 (400-ft^2) reinforced concrete structure. Radiation shielding would be provided by approximately 1-m (3 ft) thick reinforced concrete walls on three sides and a retaining wall on the fourth. The test cell would be designed to accommodate the major components of the reactor and includes sufficient penetrations to provide fluids, power, and instrumentation necessary for reactor operations. All construction associated with the test cells would incorporate materials designed to minimize neutron activation (SNL, 1990a).

2.3.2.2.1.2 Full-Scale Facility (U)

(U) Several components would be added to the existing sub-scale facility to create a full-scale facility (Figure 2.3-2). Identification of appropriate space on the sub-scale site plan is the only activity associated with these components, which would be accomplished during the sub-scale facility design effort. A separate console would be installed in the control bunker for each additional testing activity to be conducted at the test station. A test evaluation center to accommodate increased data acquisition requirements, security control systems necessitated by the additional testing program, and a disassembly building to enable on-site post irradiation examination activities would all be constructed at the expanded ground test station (SNL, 1990a).

Test Complex (U)

(U) A test complex consisting of additional test cells would be constructed as required to accommodate the additional ground testing. The proposed complex would consist of multiple test cells on reinforced concrete slab on-grade. One side of the complex would be open to allow both access for construction activities and discharge of operational effluents from the individual cells. The test cells would be similar to those described above for the sub-scale test facility. The cells would be designed to accommodate the engine test assemblies and include sufficient penetrations to provide fluids, power, and instrumentation necessary for engine operation (SNL, 1990a).

(U) The reactors would be cooled by cryogenic hydrogen, supplied from the coolant storage and distribution area. Cryogenic hydrogen from the coolant supply system would be used to fill any run tanks associated with prototypic engine configurations and provide necessary cooling immediately following a design transient. Vacuum jacketed piping would penetrate the retaining walls and enter the test cell chamber where they would be coupled to the test assemblies. Gaseous helium for testing and purging, electrical power, and instrumentation would enter the upper chambers through similar penetrations in the same walls (SNL, 1990a).

(U) Adequate measures to prevent accumulation of hydrogen gas inside the test cells would be incorporated into the design. Either air dilution and circulation or a means of inerting the existing atmosphere would be employed to preclude potential hydrogen deflagration and/or detonation in the test cells (SNL, 1990a).

[redacted]

Disassembly Building (U)

(U) A disassembly building with an integral hot cell would be required to accommodate initial disassembly and post irradiation examination of irradiated fuel elements or test reactor assemblies. The hot cell would be a closed system; all effluents would be captured and treated within the cell. The building would have an enclosed warm cell area for unloading each test article from the cask used to transport the assemblies from the test cell (SNL, 1990a).

Engine Integration Testing (EIT) (U)

(U) Space would be provided within the full-scale test facility to accommodate testing of liquid hydrogen flow components for integration into the engines. Conceptual estimates indicate that an area of approximately 150 m^2 (1600 ft^2) would be required to accommodate this testing. This testing area would provide appropriate blast protection (SNL, 1990a).

(U) An oxygen storage and distribution system would be designed and constructed as a part of the EIT facility (SNL, 1990a). Approximately 19,000 liters (5,000 gal) of liquid oxygen would be stored onsite. The oxygen would be mixed with hydrogen in a hot-hydrogen gas generator and combusted to serve as a surrogate heat source during the EIT described in Section 2.3.3.2.

[redacted]

[redacted]

2.3.2.2.1.3 Process Fluid Systems (U)

(U) The process fluids systems for the sub- and full-scale ground test facilities consist of two major subsystems: 1) the coolant storage and distribution system and 2) the Effluent Treatment System (ETS) (SNL, 1990a). These are described below:

2.3.2.2.1.3.1 Coolant Supply System (CSS) (U)

(U) The coolant supply system (CSS) is composed of the hydrogen storage system, the helium storage system, and the piping and valving for coolant distribution. These subsystems are described below:

Hydrogen Storage System (U)

(U) Three types of hydrogen storage vessels are required at the test facility, low-pressure liquid hydrogen storage, high pressure liquid hydrogen storage, and high-pressure ambient temperature hydrogen storage. The low-pressure liquid hydrogen storage would provide bulk quantities of hydrogen for all test station activities. The liquid and ambient temperature hydrogen would be mixed at high pressure to provide a variable temperature hydrogen flow to the facility test cells

[redacted]

during test operations. The high pressure ambient temperature hydrogen would also be used as a pressurant for the high pressure liquid hydrogen storage vessels (SNL, 1990a).

(U) The anticipated storage requirements for the hydrogen storage at the sub-scale facility are:

> <u>Low Pressure Liquid Hydrogen Storage</u>: Volume: 420,000 liters (110,000 gal), Pressure: 210-690 kPa (30-100 psi), Temperature: 20-320K (-250 to +50° C)
>
> <u>High Pressure Liquid Hydrogen Storage</u>: Volume: 115,000 liters (30,000 gal), Pressure: 20 MPa (3000 psi), Temperature: 20-320K (-250 to +50° C)
>
> <u>High Pressure Ambient Temperature Hydrogen Storage</u>: Volume: 310 m^3, (11,000 ft^3), Pressure: 30 MPa (4000 psi), Temperature: 300-320K (+30 to +50° C)

(U) Future expansion of the test facility to the full-scale facility could potentially increase these values by a factor of two.

(U) Reactor safety concerns require that high pressure cryogenic hydrogen be supplied to the test cell by two or more independent systems. Thus the total storage volume requirement would be equally divided among an even number of equally sized storage vessels. During normal test operation, each independent system would supply one half the hydrogen flow required by the fuel elements; however, the piping and valving associated with each independent supply system would be sized to accommodate the total flow required by the reactor fuel. If a failure occurs in one system the other system would increase flow to the reactor fuel and the test would be terminated. Operational limits would be placed on the high pressure LH_2 level and the ambient temperature gas storage pressure to ensure that each of the independent systems retains sufficient hydrogen to provide an orderly reactor shutdown (SNL, 1990a).

(U) Each of these independent hydrogen supply systems would be protected from projectiles that may result from the rupture of pressure vessels, piping, or the detonation/deflagration associated with a failure in the other system. This protection would be provided by placing shrapnel barriers in locations to isolate storage vessels associated with one independent supply system from line of sight with the vessels of the other. Additional protection for the independent hydrogen supply systems would be provided by placing shrapnel barriers in locations to isolate the high-pressure hydrogen storage vessels from the line of sight of the other storage vessels (i.e. oxygen) located at the test station. The hydrogen and oxygen storage vessels would be separated by a minimum distance of 23 meters (75 ft) (as specified in SNPA 50B) to decrease the possibility of contact and detonation/deflagration should a leak occur (SNL, 1990a).

(U) Hydrogen is very reactive in an oxygen environment. To minimize the possibility of hydrogen detonation/deflagration, the following would be implemented:

1) (U) The liquid hydrogen storage area would be graded to flow downhill away from the test facility to prevent formation of a vapor cloud in the populated areas and minimize the exposure of the test facility to the fire hazard in the event of a major liquid hydrogen leak associated with a dewar or piping failure.

2) (U) Pipe joints, fittings, valves, etc. would be installed with welded joints to the maximum extent possible to minimize the possibility of hydrogen leaks. All welds would be inspected, leak tested, and certified for use with hydrogen.

3) (U) Redundant pressure relief devices would be incorporated in the design of all fluid storage vessels to minimize the possibility of storage vessel overpressure and failure.

4) (U) Pressure relief devices would be incorporated into the design of any piping segment intended to carry cryogenic hydrogen that would be isolated by closing valves to minimize the possibility of over pressure and failure due to expansion of trapped cryogenic hydrogen.

5) (U) All lines, valves, and other system components carrying cryogenic fluids would be vacuum jacketed or protected from inadvertent human contact.

6) (U) Remotely actuated valves would be utilized to the maximum extent possible in order to minimize human interaction.

7) (U) All storage vessels, lines, etc would be purged with helium to remove all air prior to the introduction of hydrogen to prevent freezing of trapped gases and/or formation of combustible mixtures.

8) (U) All lines would be purged with helium after carrying hydrogen to prevent formation of combustible mixtures.

9) (U) Helium at low pressure would be maintained in the process fluid system piping to aid in leak detection.

10) (U) Enclosed areas where hydrogen leakage is possible would be maintained in a configuration to avoid accumulation of hydrogen (inerted and/or ventilated).

11) (U) Large hydrogen flows, such as those that occur during dewar cooldown, rapid venting of dewar storage, direct liquid flows to the vent, and normal test operations, could be vented to a flare stack and burned.

12) (U) Hydrogen off-load stations would be equipped with deluge fire suppression systems.

13) (U) Hydrogen leak detection equipment (portable and/or installed) would be incorporated into the process fluids system design.

14) (U) Hydrogen fire detectors (infrared and/or ultraviolet) would be incorporated into the process fluids system design.

15) (U) Shrapnel barriers would be incorporated into the ground test facility design to protect populated areas and other storage vessels from projectiles that may result from detonation/deflagrations in the vicinity of the hydrogen storage vessels.

16) (U) Hydrogen storage vessels would be separated a sufficient distance from oxygen storage vessels to preclude the possibility of a detonation/deflagration of the hydrogen vessels affecting the oxygen vessels.

Helium Storage System (U)

(U) Helium is required at the test facility for purging storage vessels, piping, and test articles; for pressurizing certain fluid storage vessels; and for removing decay heat from the test cell subsequent to testing operations. Helium would be stored as a gas at high pressure and ambient temperature. The helium storage vessels would be adequately protected from projectiles by placing shrapnel barriers in locations to isolate them from line of sight of the hydrogen storage vessels. The high pressure ambient temperature helium storage requirements for the sub-scale facility are:

Volume: 135 m^3 (4,700 ft^3), Pressure 20 MPa (2,800 psi), Temperature: 300-320K (30 - 50° C).

(U) Future expansion of the test facility to the full-scale facility could potentially increase the quantity of helium required by a factor of two.

(U) Coolant Distribution System. The fluids distribution piping and valving would supply hydrogen and helium to various locations at the test facility in appropriate quantities to support test and operational activities. Auxiliary equipment required by the fluids distribution system includes vaporizers to maintain pressure on the bulk cryogenic hydrogen storage dewars during transfer operations, facility pumps and vaporizers to enable filling the high pressure ambient temperature hydrogen storage vessels, filters at the fill stations and test cell to maintain fluid cleanliness, instrumentation to monitor conditions in the storage vessels and distribution systems, and mixers to deliver variable temperature hydrogen to the test cell. Fluids distribution piping, valving, and associated components will be designed to operate in the range of 690 kPa (100 psi) at 20 K (-250° C) for low pressure LH_2 lines to 40 MPa (6000 psi) at 320 K (50° C) for high pressure GH_2 lines (SNL, 1990a).

(U) Open isolation valves would be located at the inlets and outlets of all pressure vessels. Remotely actuated or pressure regulating valves would be used to control the pressure in the storage vessels. Pressure relief devices would be incorporated into the design of the isolation system to avoid over pressuring the storage vessels. Pressure relief devices would also be incorporated into the design of any feed line that may be isolated when carrying cryogenic hydrogen (SNL, 1990a).

(U) Significant releases of hydrogen would be vented to a coolant flare stack. Operations that are expected to release large quantities of hydrogen are cooldown of the liquid hydrogen storage vessels, fill of hydrogen storage vessels, and post operational purge of hydrogen feed lines. The flare system would be sized for the maximum expected flow rate resulting from these operations (SNL, 1990a).

2.3.2.2.1.3.2 Effluent Treatment System (ETS) (U)

([redacted]) An Effluent Treatment System (ETS) removes potential fission contaminants generated as a result of some of the proposed ground testing activities. There are three major reasons for incorporating an ETS into the ground test facility. First, the test matrix which supports a fuel element qualification program must include routine operations to determine and/or validate design margins. The potential for releasing a larger quantity of fission products increases as the operating parameter approaches these upper limits. The emissions of radionuclides into the ambient air from DOE facilities are regulated by the National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR61) Sub-Part H (40 CFR61.90) which specifies that the emissions shall not exceed an amount that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/year. While the NESHAPS may allow a member of the public to receive a dose of 10 mrem in a year, the [redacted] Program is committed to a design goal which reduces that maximum exposure to a dose of only 1 mrem/year, or 10% of the allowable regulatory limit. An ETS provides assurance that the emissions from planned activities would remain within the program goals under all postulated routine operating scenarios. Second, because the [redacted] program is a developmental program, there is some uncertainty in the actual composition of the effluent; an ETS is required for prudency. And third, DOE has a policy of reducing radioactive discharges to a level that is consistent with the current as low as reasonably achievable (ALARA) program principles. The effluent treatment system would be designed to reduce noble gases (xenon and krypton), halogens (iodine), volatile elements, and other fission products in the form of particulates[3].

(U) The effluent treatment system would be designed to accomplish the following objectives: 1) ensure that radioactive material entering the ETS remains in a subcritical geometry; 2) cool the test article effluent to temperatures acceptable for normal engineering materials used in gas treatment systems; 3) remove particulates and debris from the effluent stream; 4) remove halogens, noble gases, and vapor phase contaminants from the effluent stream; and 5) flare the resulting hydrogen gas to the atmosphere. The effluent passes through the ETS in 5-10 seconds, although the noble gases are removed and retained for several days to allow decay of the short-lived isotopes.

(U) The design requirements associated with the effluent treatment system specify that it would remove 99.9 percent of the most penetrating particle size and 99.5 percent of the halogens and noble gases. These values were based upon the demonstrated performance of the Nuclear Furnace as documented in the March 1973 test report (LANL, 1973).

(U) The functional relationships of the major components of the ETS are shown in Figure 2.3-3. The system components would be designed to meet the objectives described above.

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[3](U) Appendix A shows the total expected inventory of the testing activities. Chapter 4 describes the expected dose as a result of release from the ETS.

[redacted]

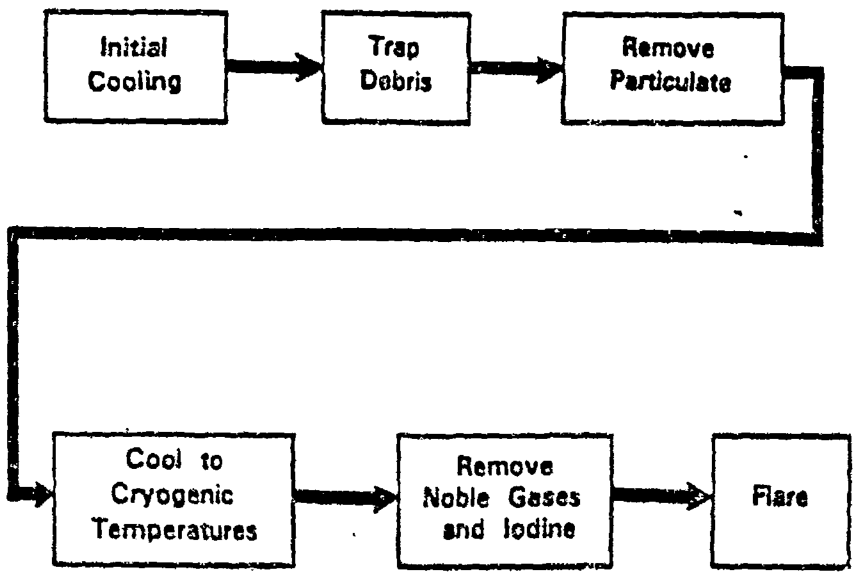

Figure 2.3-3 (U)

ETS FUNCTIONS (U)

[redacted]

Cooling Alternatives (U):

(U) Two alternatives are under consideration to perform the initial cooling of the effluent. They are: 1) a heat sink and 2) cryogenic hydrogen injection. These options may be utilized individually or in some combination to provide adequate cooling for the effluent entering the treatment system[4]. Because of the complexity added and the large volume of low-level liquid wastes that could potentially have to be solidified, water injection is not expected to be employed. These concepts are described in the following sections:

Heat Sink (U)

(U) The heat sink would be composed of a large pebble bed. The effluent would enter the pebble bed at high temperature. As the effluent flows through the bed, it would be cooled to the initial temperature of the bed. This would be a total energy limited system. The pebble bed would be sized to accommodate the total amount of energy anticipated to be generated with an appropriate safety factor. Material selection for the pebble bed is critical since the pebble temperatures at the bed entrance would very nearly equal those of the effluent. Preliminary calculations indicate that pebbles with a diameter of approximately 1-3 cm (about 1 inch) would provide adequate heat transfer effectiveness without excessive pressure drop.

(U) While the heat sink would be a passive system, its use would introduce some complications into the ETS design. By design, this option would store the energy from the effluent in a large thermal mass. Components to remove this energy from the pebble bed must be incorporated into the ETS design. If the pebble bed is to be cooled by flowing a gas through the bed, this coolant flow would be assumed to be radioactively contaminated and treated as such. It would probably be necessary to pass the cooling gas through the remainder of the ETS components. This activity has the potential to significantly increase the life cycle requirements of the ETS. Also, a reactor failure which resulted in the introduction of a large quantity of the core material into the heat sink would yield a difficult cleanup and refurbishing problem and may require premature disposal of the pebble bed as low level wastes.

(U) Using a heat sink to cool the ETS has three disadvantages. First, is the eventual disposal of the material-rich pebble bed. This would increase waste handling and disposal requirements. Second, there would be an additional need for process fluids (probably hydrogen) to cool the bed post-test. This would have implications for increased process fluids storage requirements. And finally, the longer cooling periods would require additional power.

(U) The major advantages of this concept are that 1) it is a totally passive system and 2) it provides a large thermal mass that may help mitigate the effects of some severe core disruption accidents.

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[4] (U) The final system design will be analyzed in the Safety Analysis Report.

Cryogenic Hydrogen Injection (U)

(U) The second option would inject large quantities of cryogenic hydrogen directly into the effluent stream and lower the bulk temperature through mixing. This would be a power limited concept where the required coolant flow rate is established by the power generated by the test article. Cooling by this method would significantly increase the design flow rate for the remaining components in the system (increasing hydrogen storage requirements) and would result in a larger overall ETS system.

Other Components of ETS (U):

(U) A debris retention device would be incorporated into the ETS design to serve as a core catcher (to collect any debris that may be produced by failed fuel elements) and to divert the effluent flow. This device would be designed to ensure that the material retained within it would be maintained in a subcritical configuration. Both cyclone and impactor concepts are being evaluated to perform this function. Preliminary calculations indicate that these devices could remove 99% of the particulates greater than 100 microns in diameter from the effluent stream. Consequently, it is anticipated that the majority of debris resulting from a fuel element failure would remain in the debris retention device.

(U) The effluent is then passed through a filter media designed to remove 99.9 % of the most penetrating size of the remaining particulates from the stream. In addition to providing an efficient removal media for small particles entrained in the effluent stream, the filters also provide a certain amount of redundancy for larger particles which escape the debris retention device. Granular, sintered metal, and HEPA filters, as well as other media, are being considered to perform this function.

(U) The effluent stream must be cooled to cryogenic temperatures to remove the radioactive noble gases and halogen from the effluent stream. This final cooling would be performed by injecting liquid hydrogen into the effluent stream.

(U) Incorporation of a gas-to-gas heat exchanger into the system is under consideration to use the low temperature effluent exiting the ETS to pre-cool the effluent prior to removing the noble gases. Preliminary calculations indicate that inclusion of this component could reduce the flow rate downstream of the final mixer by a factor of two.

(U) Cryogenic adsorption beds and cold traps are under consideration for use to remove 99.5% of the halogens and noble gases from the effluent stream. The performance of the cryogenic adsorption beds is a function of the bed temperature, the total bed volume, and the volumetric gas flow through the bed. The bed design must consider these parameters to ensure retention of the radioactive halogens and noble gases. The applicability of cold traps may be limited due to the very low anticipated concentration of the contaminants.

(U) Since cryogenic adsorption beds and cold traps provide only temporary retention of radioactive gases, a final collection and/or disposal method must be included in an effluent processing system. Retention of these gases for several days allows for decay of the short half

life constituents and results in a significant reduction of radioactive discharge to the environment. One alternative would be to isolate the cryogenic beds and/or cold traps and vent the gases to a cryopump. This concentrated waste would then be disposed of in an appropriate manner. A second alternative would isolate the adsorption beds and/or cold traps and allow decay of the radioactive gases followed by controlled venting to the atmosphere. These methods will be further investigated during the definitive design process.

(U) An effluent monitoring system would measure the radioactive and particulate content of the discharge stream on a real time basis in the various ETS stages and as released to the environment. This would alert the operator to releases of radioactivity and/or particulates in excess of prescribed limits (i.e. NESHAP) and would also provide post-run quantitative estimates of total releases made to the environment during each run.

(U) Finally, the remaining treated effluent would be vented through a flare stack. Intentional burning of the remaining hydrogen effluent would prevent the accumulation and potential denotation/deflagration of the hydrogen in the vicinity of the test cell (SNL, 1990a).

(U) The incorporation of a metal hydride storage system into the ETS is under consideration to adsorb the majority of the hydrogen effluent during test operations. The hydrogen would then be released from the metal hydride in a controlled manner after test operations at a greatly reduced flow rate. This concept has the advantage of delaying and retaining the effluent for the short term and allowing a significant downsizing of the ETS components.

2.3.2.2.1.4 Roads and Services (U)

(U) Roads and other service facilities (utilities such as water, power, and emergency services) would be constructed as necessary to support the operation of the test station. Standard construction practices for dust suppression would be followed (SNL, 1990a).

2.3.2.2.1.5 Site Security (U)

(U) Security at the sub-scale facility would be provided by a perimeter fence. Security would be upgraded at the full-scale facility to include appropriate fencing with security cameras and/or other detection devices. The security at the facilities would be in accordance with applicable DOE requirements.

2.3.2.2.2 Future Facility Use (U)

(U) At the completion of the planned test series, the site would be cleaned and decontaminated to a degree that would facilitate its reactivation should the need arise. Decontamination and decommissioning (D&D) of the site is presented in Section 2.3.3.5.

2.3.3 System Ground Testing (U)

([redacted]) This section describes the ground testing of the PBR engine system using a gas-cooled reactor.

([redacted]) The philosophy of the ground testing activities is to gradually approach prototypical conditions anticipated to be experienced [redacted]. Table 2.3-3 shows the matrix of ground testing activities. The proposed system ground testing would demonstrate the technology through a series of tests over a five or more year period leading to the qualification of the Particle Bed Reactor (FBR) [redacted]. In general, the ground tests are sequenced to commence with fuel element testing, progress through multiple assemblies that gradually approach prototypic condition, and culminate in a prototypic assembly fully qualified for application to [redacted]. Specifically, this test series includes the Particle Bed Reactor Integral Performance Element Tests (PIPET) and the Engine Integration Tests (EIT) as well as tests of the Mini Ground Test Article (mini-GTA), the full-scale Ground Test Article (GTA) and the Qualifying Test Article (QTA).

([redacted]) The primary effluent from these tests would be hot hydrogen gas expelled from the reactors. [redacted]. The hydrogen would be intentionally ignited (flared) after passing through the system. Upwards of 50,000 kg (110,000 lb) of hydrogen could be used in each test (SNL, 1990a).

([redacted]) Fission-product retention performance of the fuel particles would be evaluated during testing activities which would be conducted prior to initiation of the ground test series. Quality assurance data for U.S. fuel similar to that planned for use in the reactors indicates that, during normal operations, 99.99 percent of gaseous fission products would be retained [redacted] there is the potential for increased fission product release (Vernon, 1991; Wright, 1991). Prior to ground testing, specific release fractions would be evaluated during a planned test program. Analysis of related research and assessment of projected operational conditions were used to predict the following release rates: noble gases, 8%; halogens, 5%, volatiles; and particulates, 0.4%. The vast majority of solid fission products would be retained (SNL, 1990b).

([redacted]) Subsequent to completing the final operating cycle associated with a core assembly, the test article would be removed from the test cell and transferred to an appropriate location within the test station complex to allow for decay of the radioactive fission products, followed by appropriate post irradiation examination (on or off site) and ultimate disposal. All necessary transportation would be performed in appropriately shielded containers in accordance with applicable federal (DOT), state and local regulations. Transportation is discussed in detail in Section 2.4.2.

Planned Test Operation (U)

(U) Standard operating procedures would be prepared for each test. Each test series would be carefully planned to include written procedures and formal review and approval. Procedures would also be developed for material receipt, storage, preliminary assembly, postirradiation component disassembly, inspection of major components, and associated transportation requirements.

[redacted]

TABLE 2.3-3: SUMMARY OF GROUND TESTING ACTIVITIES[1] ([redacted])

TEST	ARTICLE DESCRIPTION	TEST DESCRIPTION	NO CORES	NO TESTS	TIME/ TEST	TOTAL TEST DURATION	MAX POWER	MAX TEMP[3]
PIPET	[redacted] nozzle.	Self-sustained, power producing PBR test.	6	5 each core. 30 total.	Up to 500 seconds for each of 5 tests	1-3 months per core. 3 years total.	550 MW	[redacted]
EIT	Mock-up of entire propellant management system.	Test of propellant system under non-nuclear representative temperatures and pressures.	non-nuclear	Approx 50	Few seconds to several minutes	thru test program (up to 10 years)	non-nuclear	[redacted]
mini-GTA	A [redacted] subscale version of the GTA.	Operated similar to the PIPET.	2	5 each core. 10 total.	500 sec each test	1-3 months per core. 1 year total.	550 MW	[redacted]
GTA	Full scale [redacted] PBR with feed and control hardware.	Test of system in stages to somewhat less than flight power. GTA 1 - low power. GTA 2 - close to full power.	4	Up to 5 each core. Up to 20 total.	Few seconds to 1000 seconds	1-2 years	2 GW[2]	[redacted]
QTA	Turbopump assembly, valves, and control system to be used by the flight test article as well as a truncated nozzle and a liquid hydrogen run tank.	Qualification of complete propulsion system for flight.	1	1 total	1000 sec	2 or more months	2 GW	[redacted]

[1] Number of cores, tests, duration and temperature may be adjusted to respond to data needs.
[2] Initial tests are expected to be limited to 1 GW.
[3] Maximum mean outlet temperature.

[redacted]

(U) A Remote Inspection and Maintenance System (RIMS) would be provided to permit timely evaluation of the test reactors in a high-radiation environment. The capability to conduct multiple operations using the same reactor core assembly depends on the ability of this system to verify the integrity of the fuel element prior to commencing each reactor operation (SNL, 1990a).

(U) Each test sequence would undergo a comprehensive safety analysis as described in Section 2.4.3. Analysis of safety would be conducted in accordance with DOE procedures for preliminary and final Safety Analysis Reports. An outline of the Preliminary Safety Analysis Report (PSAR) for PIPET is provided in Appendix B.

<u>Environmental Qualification</u> (U)

([redacted]) The engine would be qualified for many environmental extremes. Component level qualification tests conducted by suppliers would be the primary means of qualification for the following environments: humidity, vibration, shock, acceleration, noise, overpressure, and temperature. Sub-scale and full-scale development testing at the ground test site serves to confirm that the operationally imposed system level stresses are not more severe than the levels at which the component was qualified. For the radiation environment, the ground test program serves to qualify the total system, and inclusively, the components thereof (Grumman, 1991).

(U) The engine would also be qualified for shrapnel impacts. The necessity of considering shrapnel impacts is based on the possibility of high velocity fragments resulting from potential turbopump disassembly impacting other components. This, in turn, is based on the breakup characteristics of the turbopump, and its placement relative to their components. The need for qualification testing for shrapnel exposure would be determined when turbopump development has progressed to the point where these characteristics can be identified (Grumman, 1991).

2.3.3.1 PIPET (U)

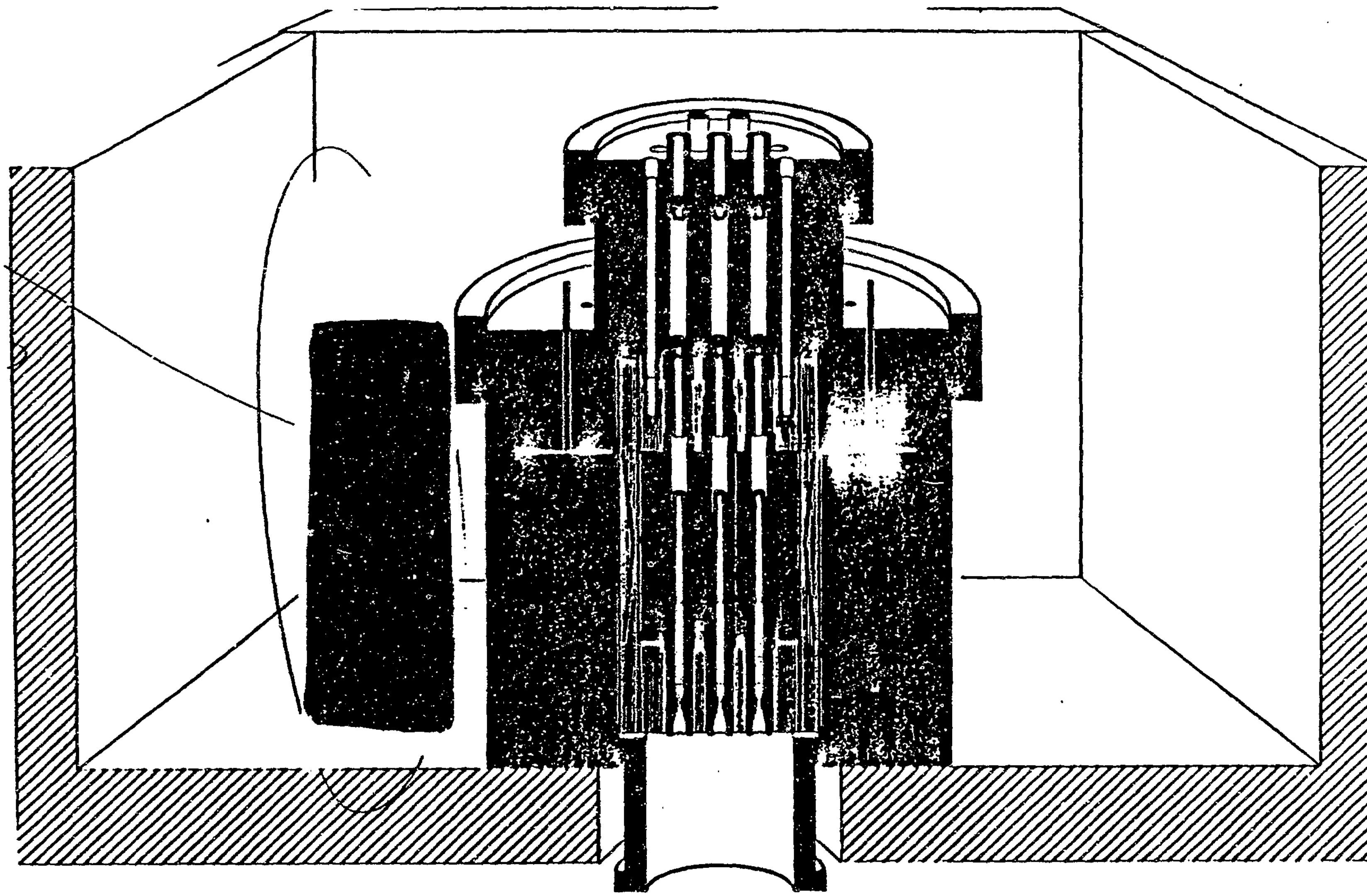
([redacted]) The PIPET test would be the first self-sustained, power producing PBR test. This test would demonstrate the reactor fuel element operation at prototypic power densities, temperatures, pressures, flow rates, and power durations. The reactor would contain seven prototypic fuel elements. Data would be obtained on the fuel element, materials, and thermal hydraulic performance.

<u>PIPET Description</u> (U)

([redacted]) The PIPET configuration is shown in Figure 2.3-4. The current design indicates that the physical size of the reactor is [redacted].

([redacted]) While the PIPET moderator design continues to evolve, [redacted]

[redacted]



CUTAWAY VIEW OF PIPET WITHIN TEST CELL WITH CANISTERS INSTALLED

PIPET CONFIGURATION

Figure 2.3-4

[redacted]

[redacted]).

([redacted]) The reflector assembly would consist of reactor grade graphite. The reflector assembly can consist of either cooled or uncooled graphite assemblies. Cooled assemblies may be required if extended operation is required. [redacted].

(U) Under the current design, this nuclear reactor has at least two coolant requirements, the first for the PBR fuel elements undergoing testing, and the second for the safety rod assemblies and confinement structures (SNL, 1990b).

Pre-Test Activities (U)

(U) The PIPET fuel elements and major components can be shipped to the receiving/assembly building for assembly. [A second option is to ship the assembled devices as one unit.] Department of Transportation (DOT) certified containers are available for either type of shipment. Following receipt and component assembly, preoperational inspections and testing would be required. Upon completion, the reactor components would be taken to the sub-scale test cell for installation for further preoperational testing and test operations.

PIPET Testing (U)

([redacted]) The initial PIPET assembly would consist of [redacted] prototypic elements and [redacted]. Supplemental low-power assist elements may also be placed in the PIPET moderator region if necessary to assure sufficient reactivity margin. [redacted]. Each of the cores could be subjected to 5 operating cycles at a maximum power level of 550 MW_{t} for as long as 500 seconds per cycle, with a minimum of 7 days separating each operating cycle (SNL, 1990b; SNL, 1990a). Krypton, iodine, volatiles, and particulates would be present in the exhaust stream. The total inventory for a 500 second run is shown in Table A.1-1 in Appendix A.

([redacted]) The hydrogen coolant would enter the reactor at temperatures [redacted], while the hydrogen coolant from the moderator and reflector assemblies and the safety rods would exit at significantly lower temperatures. Additional hydrogen coolant may be necessary to cool the nozzles and their attachment (SNL, 1990b).

(U) Cryogenic and ambient temperature hydrogen would be mixed externally to obtain high pressure cryogenic hydrogen, which would then be supplied to the test article. Hydrogen would be used for immediate post-test cooling of the reactor core, followed by purging and decay heat removal using helium at moderate flow rates and temperatures (SNL, 1990a; SNL, 1990b).

([redacted]) As part of the PIPET testing, one or more fuel elements (described in Section 2.2.1) would be tested to failure to determine the design margins. Failure would occur when the available fission product is sufficiently low so as not to impinge on NESHAP requirements. Failure of [redacted] would still be more than an order of magnitude below NESHAP standards, while failure of one element would be more than two orders of magnitude below NESHAP standards. (Minimizing the number of fuel elements in the system allows for lower coolant requirements, smaller quantities of special nuclear material, and smaller quantities of fission products than would be present if a full size engine were tested.) (SNL, 1990a).

<u>PIPET Effluent</u> (U)

([redacted]) The primary component of the effluent stream is high temperature hydrogen gas at a [redacted]. Trace quantities of noble gases (xenon and krypton), iodine, volatiles, and particulates could be present in the exhaust stream. The effect of 5 runs of 500 seconds each on the inventory is shown in Appendix A to be small.

(U) The PIPET effluent would be processed by the Effluent Treatment System (ETS) to ensure that concentrations of radioactive material effluent are maintained to a level as low as reasonably achievable (ALARA). (The ETS was described above in Section 2.3.2.2.1.3.2).

([redacted]) The maximum fission product inventory associated with PIPET is that inventory which could result from a single operation of 2500 seconds at a maximum power level of 550 $MW_{(t)}$ (1.375 E6 Megajoules). The maximum fission product inventory associated with PIPET testing would be reduced by radiological decay below the 550 MW inventory by the 7 day separation between the 5 operating cycles. The radiological dose[5] from the PIPET tests without the ETS in place would be 8.8×10^{-1} mrem while the projected dose from the PIPET tests with the ETS in place would be 9.7×10^{-3} mrem.

<u>PIPET Dose Rates</u> (U)

([redacted]) Post irradiation dose rates from the PIPET systems, at one meter from the surface, are expected to range to a maximum of 500 rem/second during operations, 3 rem/minute 24 hours after shutdown, and 3 rem/hr several days after shutdown. There would be a necessary cooldown period of up to several weeks prior to core removal after a series of tests.

<u>Engine Component Tests</u> (U)

([redacted]) Engine Component Tests at the PIPET facility are a series of development tests to expose system components to the hot hydrogen and radiation environment. A special nozzle may be installed to tap off hot hydrogen to feed such propellant management system components as the mixer, the speed control valve and the turbine. The PIPET radiation environment would be used to expose and evaluate critical flow or control system components.

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[5](U) This is the dose to the hypothetical individual residing at the location of maximum dose. See Section 4.3.4.2 for a more complete description.

2.3.3.2 Engine Integration Tests (EIT) (U)

([redacted]) Engine Integration Tests (EITs) would be tests designed to demonstrate the propellant management system without an operating reactor in the loop. A mock-up of the entire [redacted] system would be tested using a gas generator system to produce hot hydrogen to power the turbopump for system checkout. The gas generator system would consist of a liquid oxygen/liquid hydrogen combuster, a steam/hydrogen heat exchanger, a liquid oxygen tank, a liquid hydrogen run tank, and a tank pressurizing system. Chill and purge procedures would be developed and leak checks and functional tests performed. Off design and failure mode testing would also be performed. The EIT series would establish the confidence in the control and feed system necessary to allow proceeding to the Ground Test Article (GTA) engine system tests. Under current plans, the EIT series would be performed at the system ground test facility described in Section 2.3.3. The use of off-site facilities for portions of the EIT are also being evaluated.

([redacted]) During the EIT, liquid hydrogen at pressures of 310-345 kPa (45 to 50 psi) would be fed into the pump side of the turbopump assembly; the gas generator would produce hydrogen gas at temperatures of approximately 2700 K (2430° C) which would be used to drive the turbine side of the turbopump assembly. Performance of various components at measured pressure, temperature, and flow conditions would be monitored. Waste products consisting of hydrogen and helium gases and steam would be vented to the atmosphere. Individual test runs would last a few seconds to several minutes periodically throughout the ground test program.

2.3.3.3 Ground Test Article (GTA) (U)

([redacted]) The Ground Test Articles (GTA) are a series of from two to six reactors which gradually approach the desired prototypic conditions of the QTA. The GTA design would evolve from technical information derived during PIPET and other program testing. The GTA tests would employ the cut back nozzle configuration, and through a progressively expanding test envelope, expose the nozzle to the full mission profile values of temperature, pressure, flow rate and nuclear radiation fields.

2.3.3.3.1 Mini-GTA (U)

(U) The mini-GTAs are [redacted] designed to be subscale versions of the GTA. Subsequent to satisfactory operations associated with PIPET, two mini-GTAs would be subject to tests in the same sub-scale test cell used for PIPET.

([redacted]) The mini-GTA reactors would be designed to represent more closely a prototypic full size GTA fuel element and would be operated similar to the PIPET in the sub-scale facility test cell. Approximately 5 tests, each of 500 second duration, would be performed on each of the 2 mini-GTAs. [redacted]. The test matrix could potentially generate a fission product inventory in the two reactors similar to that generated in the PIPET cores. The total inventory for a 500 second run is shown in Table A.1-1 in Appendix A (SNL, 1990b). The

radiological dose from the mini-GTA is expected to be the same as that for the PIPET (8.8 x 10^{-1} mrem without the ETS in place and 9.7 x 10^{-3} mrem with the ETS).

2.3.3.3.2 Full-Scale GTA (U)

([redacted]) The full-scale GTA test series would demonstrate a complete [redacted] PBR operation with feed and control hardware and a full complement of instrumentation including the prototype planned [redacted] sensors. Multiple tests (up to five) would be performed on each of the full-scale GTAs (up to four). The tests would build up from critical (zero power), to low power, to somewhat less than [redacted] operational power and temperatures ([redacted]). These tests would demonstrate controllability and stability at full power and rapid start-up and shutdown under computer control over a simulated full mission profile. The engine mass would be approximately [redacted].

([redacted]) The test series would progress from a cold flow test in which the hydrogen gas is passed through the reactor while the core is held in a subcritical condition to tests in which the reactor is held critical at full power levels. The initial test would have the instrumentation and controls attached remotely to the test article. Subsequent tests would be conducted with the instrumentation and controls attached directly to the test article to more closely simulate prototypical conditions.

([redacted]) The duration of each test would be on the order of a few minutes. The maximum time at full reactor power for any individual core assembly of the GTA test series would be approximately 1000 seconds (SNL, 1990a). The test matrix associated with each of these reactor cores could potentially generate a fission product inventory (described in Chapter 4) resulting from a single 1000 second operation at a maximum power level of 2.0 GW (2E6 megajoules). The total inventory for a 1000 second run is shown in Table A.1-2 of Appendix A. These tests would be conducted at intervals to allow for reactor cool down and evaluation of data between tests (SNL, 1990b). The radiological dose from the GTA tests is expected to be 5.9 mrem without ETS in place and 6.9 x 10^{-2} mrem with the ETS).

([redacted]) The GTA baseline design includes a turbopump assembly which supplies cryogenic hydrogen to the reactor at the design operating pressures and temperatures. During operations, the coolant supply system must supply liquid hydrogen directly to the test article at a [redacted].

(U) Cryogenic hydrogen for the full-scale GTA test series would be supplied from a large liquid hydrogen tank and pressurized using a turbopump assembly included as a part of the test article. An alternate design would employ a facility pump to supply liquid hydrogen from low-pressure storage tanks. The supply system selected would depend upon design trade-offs.

(U) Approximately 1,000 kg (2,200 lb) of hydrogen would also be used for immediate post test cooling to be followed by 15,000 kg (33,000 lb) of helium at sufficient pressure [approximately 1.4 MPa (200 psi)] to complete the cool down, purging and inerting of the test articles, the test cell and the ETS. This procedure could take several weeks (SNL, 1990b; SNL, 1990a).

2.3.3.4 Qualification Test Article (QTA) (U)

([redacted]) The Qualification Test Article (QTA) would be a complete engine system. It would be identical to the [redacted] test article in every way possible, and the test profile would be identical to the flight test profile in every way possible. The engine would (1) represent the [redacted] engine hardware and software and [redacted] ([redacted]), and (2) qualify the engine and control system [redacted]. The QTA would include the turbopump assembly, valves, and control system to be used [redacted].

([redacted]) The QTA baseline design includes a turbopump assembly which supplies cryogenic hydrogen to the reactor [redacted]. [redacted]. The maximum time at full power for QTA test reactor is assumed to be 1000 seconds. The total inventory for a 1000 second run is the same as the inventory for the GTA shown in Table A.1-2 of Appendix A. (SNL, 1990b). The radiological dose from the QTA is expected to be the same as that for the GTA (5.9 mrem without the ETS in place and 6.9 x 10^{-2} mrem with the ETS).

(U) Following the test, hydrogen from another tank would be used to initially cool the QTA test article. Then ambient temperature helium would be used for final decay heat removal and purging. As with the GTA, this procedure could take several weeks (SNL, 1990a).

2.3.3.5 Decontamination and Decommissioning (D&D) (U)

([redacted]) The ground test facility would be developed in support of [redacted] activities. However, the same facility may be used to support related research and development of nuclear propulsion systems for other applications. This facility is expected to be adaptable for use by other such programs following appropriate safety and environmental analysis and documentation.

(U) In the event that a period of inactivity should become necessary, the facility would be preserved in such a fashion that re-activation could be accomplished with the minimum of expense and in a timely manner. All readily accessible areas would be decontaminated to a level allowing general access in accordance with appropriate safety requirements.

(U) Upon completion of usable service, the facility would be decontaminated and the area restored to as near original state as deemed practical by the cognizant authorities at the time. DOE Order 6430.1A (General Design Criteria) would be applied to the design activities to enhance eventual decommissioning activities.

(U) A decontamination and decommissioning (D&D) plan would be prepared for the ground test facility prior to the acceptance of any special nuclear material. The plan would be consistent with Department of Energy Order DOE 5820.2A Chapter V: Decommissioning of Radioactively Contaminated Facilities and would contain the following elements:

(a) (U) physical, chemical, and radiological characterizational data or references to such data;

(b) (U) a summary evaluation of decommissioning alternatives for the facility including the preferred alternative;

(c) (U) plans for meeting requirements from the environmental review process (National Environmental Policy Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and the Superfund Amendments and Reauthorization Act) and all necessary permits;

(d) (U) radiological criteria to be used (modifications, if any, to guidance presented in applicable EH Orders must be approved by the Headquarters program organization and EH-1);

(e) (U) projections of occupational exposure;

(f) (U) estimated quantities of radioactive waste to be generated; and

(g) (U) detailed administrative, cost, schedule, and management information.

(U) The D&D plan would be updated at the completion of testing at the sub-scale level and at the completion of each major test program but no less frequently than every five years.

2.3.4 [redacted] (U)

([redacted]) The goal of the [redacted] program is the successful [redacted] test of PBR technology. [redacted]

[redacted]

[redacted]

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[4](U) In the event of an earth re-encounter, in even as little as 10 years, the fission product inventory would have decayed to very low levels.

[redacted]

2.3.4.1 [redacted]

[redacted]

([redacted]) [redacted]

([redacted]) [redacted]

[redacted]

[redacted]

2.3.4.2 [redacted]

([redacted]) [redacted]

[redacted]

Figure 2.3-5 (U)

PROPOSED [redacted] ARTICLE (U)

[redacted]

[redacted]

Blacked
OUT

Figure 2.3-6 [redacted] (U)

[redacted]

([redacted]) [redacted]

([redacted]) [redacted]

[redacted]

2.4 [redacted] SUPPORT ACTIVITIES (U)

(U) This section describes waste management, transportation issues, and safety.

2.4.1 Waste Management (U)

(U) This section describes the radioactive, hazardous, and non-hazardous waste management procedures that would be followed as part of the [redacted] program for wastes generated by ground testing activities. Each type of waste is also shown in Table 2.4-1. The waste management procedures are described in a generic manner. Site specific waste management is described for each alternative testing location in Chapters 3 and 4.

(U) Materials and component development facilities will generate small quantities of waste as a result of program activities. Site-specific waste management and inputs of [redacted] program generated waste at the facilities are discussed in Chapters 3 and 4 respectively. Each individual facility would be responsible for the management of waste that are generated at that facility.

<u>Radioactive Waste</u> (U)

(U) All radioactive waste materials generated during program activities are classified as defense wastes, which would be managed in accordance with DOE Order 5820.2A (Radioactive Waste Management), DOE Order 5480.11 (Radiation Protection for Occupational Workers) as well as any local protection regulations or guidelines. The radioactive waste potentially generated would be high-level waste (HLW), transuranic (TRU) waste, low-level waste (LLW), and low-level mixed waste (MW). Each type of radioactive waste and its impact on waste management is described below:

([redacted]) <u>High-Level Radioactive Waste:</u> It is currently anticipated that with the relatively short operating times, the fuel material would not contain any TRU's in excess of 100 nCi/g and the resultant material would be certified as fissionable test specimens. Any associated waste products would be disposed of as LLW. The only material anticipated to be generated in association with the [redacted] program ground testing activities that would be certified as HLW would be in the form of spent reactor fuel. Should this occur, the HLW would be isolated at the ground test station pending final disposition which would be accomplished in accordance with the defense HLW program procedures.

(U) <u>Transuranic Waste:</u> Transuranic wastes from program activities are not anticipated to exceed 30 m^3 (1000 ft^3). The TRU waste would primarily be the irradiated fuel elements, if the concentration of transuranic materials, elements with atomic number higher than 92, were greater than 100 nCi/g.

(U) <u>Low-Level Radioactive Solid Waste:</u> It is anticipated that the low-level radioactive solid waste generated by the program would be on the order of 46,000 cubic meters (1,600,000 cubic feet) over the life of the project. [Included in this are an expected 6,100 m^3 (220,000 ft^3) of concrete and steel and 1,500 m^3 (50,000 ft^3) of aluminum from decontamination and de-

[redacted]

TABLE 2.4-1: HISTORICAL AND ANTICIPATED WASTES AT GROUND TEST FACILITY (U)

TYPE OF WASTE	REMAINING CAPACITY		ANNUAL INPUT		[redacted] GENERATED WASTES
	NTS	INEL	NTS	INEL	ANY SITE
HIGH LEVEL LIQUID WASTE	No Capacity (Leppert, 1991)	15,200 m³ (DOE, 1991a)	Not Applicable	3,800 m³: 3,700 m³ present 140 m³ w/NPR** (DOE, 1991a)	None
HIGH LEVEL SOLID WASTE	No Capacity (Leppert, 1991)	10,000 m³ (DOE, 1991a)	Not Applicable	765 m³: 740 m³ present 25 m³ w/NPR** (DOE, 1991a)	None
TRANSURANIC WASTE	1,200 m³ - mixed 1,000 m³ - TRU* (Leppert, 1991)	395,000 m³ (DOE, 1991a)	No Current	2,900 m³: 2,800 m³ present 100 m³ w/NPR** (DOE, 1991a)	30 m³
LOW LEVEL LIQUID WASTE	No Capacity (Leppert, 1991)	100,000 m³ (DOE, 1991a)	Not Applicable	1,800 m³: 1,000 m³ present 800 m3 w/NPR** (DOE, 1991a)	None
LOW LEVEL SOLID WASTE	380,000 m³** (Leppert, 1991)	100,000 m³ (DOE, 1991a)	25,000 m³	5,100 m³: 2,900 m³ present 2,200 m³ w/NPR** (DOE, 1991a)	46,000 m³
MIXED WASTE	166,300 m³** (DOE-NA, 1991)	80 m³ (Nelson, 1991)	20 [illegible] m³	172 m³: 12 m³ present 160 m³ w/NPR** (DOE, 1991a)	0.2 m³
HAZARDOUS WASTE	Accumulation only - (offsite disposal) (Leppert, 1991)		100 m³	1,250 m³: 100 m³ present 1,100 m³ w/NPR** (DOE, 1991a)	15 m³
SANITARY LIQUID WASTE	Not Applicable	Not Applicable		252,000 m³: 230,000 m³ present 22,000 m³ w/NPR** (DOE, 1991a)	7,000 m³ (construction) 11,000 m³ (operations)
SOLID WASTE	A-23 - 10/12 yrs A-9 - 15 yrs (Leppert, 1991)		A-23, 1200 t/yr A-9, 2000 t/yr	37,900 m³: 37,000 m³ present 900 m³ w/NPR** (DOE, 1991a)	4,000 m³

* (U) [illegible] TRU capacity at NTS is "storage only."
** (U) [illegible]
** (U) [illegible]

[redacted]

[redacted]

commissioning activities.] The possible use of a pebble bed cooling system could increase the volume of LLW by up to 10 percent.

(U) LLW requiring disposal would consist of solid wastes from the handling, cleaning and disassembling of the canister assemblies as well as contaminants removed directly from the effluent stream. This material would be transferred from the testing location to the local radioactive waste management site for disposal. In addition, the irradiated fuels and irradiated test samples would be disposed of as LLW provided that these materials are determined by DOE to be wastes.

(U) Mixed Waste: Some mixed waste may be generated during program activities. This would include low-level radioactive materials contaminated by solvents or solvent residues. It is anticipated that no more than 0.2 m^3 (7 ft^3) or that material that could be contained in a single 210 liter (55 gallon) drum would be produced by program activities. Mixed wastes would be contained at their point of generation and characterized, for eventual compliance with Land Disposal Restrictions (LDR), and the installation waste disposal requirements. Every effort would be made to minimize or totally eliminate quantities of mixed wastes generated by the testing.

Hazardous Waste (U)

(U) Very little hazardous solid wastes would be generated during facility operations. Hazardous wastes that would be produced as a result of facility operations include limited quantities of solvents and materials such as gloves, paper, and cloth that contain absorbed solvents. The quantities of hazardous non-radioactive waste material anticipated to be generated during the ground testing activities are estimated to be approximately 15 m^3 (500 ft^3). Generation of hazardous waste would be minimized by controlling the quantity of solvent material used in association with all activities at the testing location.

(U) Hazardous wastes generated as a result of operations would be collected at the ground test station up to a specified limit of 210 liters (55 gal) per waste stream and then transferred to the Area 5 Hazardous Waste Accumulation Pad for ultimate disposition at an EPA-approved treatment, storage, and disposal facility offsite within the 90 day accumulation period. All EPA and DOT regulations (i.e. 40 CFR 262-263 and 49 CFR 100-199) for the handling, sampling, manifesting, packaging, and shipment preparation of hazardous wastes would be followed.

Non-Hazardous Waste (U)

(U) Sanitary effluents generated during construction activities would be collected in temporary facilities and removed by the designated waste removal contractor. Post-construction sanitary effluents would be discharged to the septic tank/leach field system provided at the testing location.

(U) Facility construction would generate typical quantities of non-hazardous wastes normally associated with these activities. These wastes would be temporarily stored at the construction site pending final disposal at an appropriate sanitary land fill in accordance with the requirements

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TABLE 2.4-2: TRANSPORTATION QUANTITIES AND DISTANCES FOR SITE ALTERNATIVES (U)

Alternative	Site	Origin	Destination	Material	Estimated Quantity of Material	Estimated Number of Shipments	Kilometers Per Shipment	Percent of Travel Rural	Percent of Travel Suburban	Percent of Travel Urban
1	NTS	Lynchburg, VA	Albuquerque, NM	Fresh Product		83	2731	76%	23%	1%
		Albuquerque, NM	Mercury, NV	Fresh Product		83	1043	87%	12%	1%
		Mercury, NV	Mercury, NV	LLW*		3523**	50	100%	0%	0%
		Mercury, NV	Albuquerque, NM	Irradiated Product		83	1043	87%	12%	1%
		Albuquerque, NM	Lynchburg, VA	Irradiated Product		83	2731	76%	23%	1%
		Mercury, NV	Carlsbad, NM	TRU Waste		1	1492	87%	12%	1%
2	INEL	Lynchburg, VA	Albuquerque, NM	Fresh Product		83	2731	76%	23%	1%
		Albuquerque, NM	Idaho Falls, ID	Fresh Product		83	1801	87%	12%	1%
		Idaho Falls, ID	Idaho Falls, ID	LLW*		3523**	50	100%	0%	0%
		Idaho Falls, ID	Albuquerque, NM	Irradiated Product		83	1801	87%	12%	1%
		Albuquerque, NM	Lynchburg, VA	Irradiated Product		83	2731	76%	23%	1%
		Idaho Falls, ID	Carlsbad, NM	Tru Waste		1	2250	87%	12%	1%

* (U) On-site transportation of LLW is assumed to be 50 Kilometers for all sites.
** (U) Includes 11 shipments of mixed waste to on-site mixed-waste-processing facility.

[redacted]

conservatively estimated 50 kg (110 lb) shipment of U-235 would not exceed 100 milliCuries (mCi). This is significantly below the 200 mCi limit for A2 quantities and would not require shipment in a Type "B" shipping container.

(U) All proposed shipments consist entirely of fresh, non-irradiated uranium fuel which results in negligible radiation exposures both at the surface of the transportation trailer and within the driver's compartment. Radiation surveys at the point of origin would demonstrate that spreadable contamination levels are negligible and well within 2000 disintegrations per minute per 100 cm^2 (DPM/100 cm^2). All shipments would comply with the requirements of DOT regulations (49 CFR 170-179).

(U) A criticality analysis has been performed and there is currently no credible scenario which could cause the material to be repositioned into a critical mass during a hypothetical roadway accident. In the event that future analyses identify a credible scenario which results in accidental criticality, the quantity of material to be shipped would be reduced below the threshold level for that criticality accident. In the event that the SST vehicle is involved in an accident, the worst case scenario involves spreading the fuel particles over the ground in close proximity to the point of the accident. Should this occur, instrumentation is currently available to locate the dispersed material and acceptable methods currently exist to recover all the nuclear fuel.

2.4.2.2 Irradiated Materials and Special Wastes (U)

(U) Transportation of specimens for post-irradiation examination is routine between test reactors and laboratories. Existing DOT approval procedures would be used. All shipments of radioactive materials including Special Nuclear Material would be accomplished in accordance with the specific requirements at NTS or INEL. Arrangements would be made through the respective installation O&M contractor (SNL, 1990b).

2.4.3 [redacted] Safety Policy (U)

([redacted]) The [redacted] Program involves reactors and a test facility which are owned by DOE, located on a DOE site, and operated by a DOE contractor. It is the policy of DOE that all its activities be conducted so as to ensure the protection of the environment and the health and safety of the public and workers. With respect to radiation hazards, it is DOE's policy, as stated, for example, in DOE Order 5480.11, to implement radiation protection standards consistent with guidance promulgated by the Environmental Protection Agency (EPA), the recommendation of both the National Council on Radiation Protection and Measurements (NCRP) and the standards imposed by the Nuclear Regulatory Commission (NRC) on its licensees. Further, it is DOE policy (as stated in Title 10 Code of Federal Regulations, Part 20) that all exposures and releases of radioactive materials are to be kept as low as reasonably achievable (ALARA), taking into consideration the state of the technology, economics, societal benefits, and other relevant criteria. Radiation exposures resulting from accidents within boundaries of the United states would be shown by analysis to be less than those given in 10 CFR 100. For the [redacted] ground test facility, the more restrictive requirements of ANSI/ANS 15.7 standards for research reactor site evaluation are applied.

([redacted]) Nuclear safety requirements, derived from existing applicable regulations, dose standards, and guidelines, would be incorporated into all appropriate design specifications and test plans for the [redacted] program. The reactor systems contractor, the national laboratories, and the flight vehicle contractor would verify through formal reports and a systematic schedule of reviews and assessments that designs, specifications, and test plans meet accepted nuclear industry safety requirements. The reactors would be designed to avoid inadvertent criticality under any circumstances.

([redacted]) Specific information regarding nuclear safety policies is available in "The Safety Policy Implementation Guidelines and Goals of the [redacted] program" [redacted].

(U) Specifically, safety considerations would include:

1) (U) protection of health and safety of the public,

2) (U) protection of the health and safety of employees where program activities are performed,

3) (U) protection of the environment and lands from contamination or damage as a result of program activities, and

4) (U) protection of the property and facilities used in the program.

(U) It is the policy of the [redacted] program that:

1) (U) Safety would be considered and incorporated into each activity or system from the onset. Safety must not and would not be treated as an afterthought.

2) (U) Safety would continually be considered and assessed throughout the design, development, testing and demonstration phases of the [redacted] program.

3) (U) Explicit consideration of the effects on safety would be an essential element of every design, development, test and operational decision made in the [redacted] program.

4) (U) Safety considerations in the [redacted] program would include consideration of credible abnormal and accident situations that could occur during the entire life-cycle of the program.

5) (U) The [redacted] program would meet mandated, statutory and legal requirements for safety. The requirements to be met include Air Force Flight Recommendations, Department of Energy Orders (and those standards incorporated by the Orders), the National Environmental Policy Act (NEPA), the Occupational Health and Safety Act (OSHA), and applicable DOD requirements.

6) ([redacted]) To the extent practicable, the [redacted] program would seek to achieve the highest levels of safety in the design, testing, operating and demonstration of the [redacted] technology. Every practical effort shall be made to maintain risks due to radiation and toxic material exposures to ALARA levels.

7) (U) Safety is the responsibility of the line management of the [redacted] program. Each individual in the Program shares in the responsibility to achieve outstanding levels of safety.

(U) No tests would be performed without the safety reviews required by applicable regulations. The Preliminary Safety Analysis Report (PSAR) is the initial treatment of safety. Its objective is to provide reasonable assurance that all applicable standard can be met, i.e., that all credible safety issues have been identified and can be adequately resolved before testing begins. Approval of the PSAR is required to initiate construction of the test facility. The Final Safety Analysis Report (FSAR) presents the data and analysis substantiating that all safety issues have been resolved. Approval of the FSAR is required to initiate testing.

(U) A Safety Analysis Report (SAR) is in preparation for the initial (PIPET) tests. The elements of the SAR are presented in Appendix B.

<u>Safeguards and Security</u> (U)

(U) Safeguards and physical security would be provided for protection of both [redacted] Special Nuclear Material (SNM) contained in the sub-scale test reactor fuel elements and the classified information and components, that would be present at the test station. An expanded safeguards and physical security system that would provide adequate protection for [redacted] Special Nuclear Material (SNM) and classified information and components, would also be located at the test station during full scale testing activities (SNL, 1990a).

(U) An "improved risk" level of fire protection would be used. All fire protection systems would be fabricated and installed in accordance with National Fire Protection Association (NFPA) Standard 13 for Ordinary Hazard Group 2 (SNL, 1990a).

<u>Effluent and Environmental Monitoring</u> (U)

(U) Monitoring programs at the ground test facility would be conducted to determine: (1) the overall impact of facility operations on the environment, (2) whether environmental levels of radioactivity comply with applicable standards, (3) whether containment and control systems at facilities are functioning as planned, and (4) long-term trends of concentrations of radioactivity in the environment and any changes in those trends. Environmental impacts are determined by measuring radionuclides in the environment, where such measurements are possible, or by modeling the transport of radionuclides through environmental pathways in cases where environmental concentrations are too low to measure. Measurements within the test facility and at the test facility boundary are frequently compared to similar measurements of background locations. All measured concentrations would be compared to applicable environmental standards.

([redacted]) The environmental pathways by which radioactivity could affect the population in the vicinity of the test facility are through direct radiation exposure, atmospheric transport, soils, water, foods, and/or animals. The environmental monitoring program for the test facility and vicinity includes the collection and analysis of samples from these potential exposure pathways. The [redacted] program would augment existing environmental programs in situations where they do not provide

for adequate monitoring of all potential pathways associated with [redacted] program testing activities. The analytical methods for environmental samples are carefully reviewed to verify that such analyses are made with sufficient sensitivity to verify compliance with appropriate standards. High reliability is obtained by a stringent quality assurance program.

Hydrogen Safety (U)

(U) Introduction: Large quantities of hydrogen have been used at industrial and rocket facilities for a number of years. A review of cryogenic hydrogen safety issues related to bulk storage and operations is given by Edeskuty (1991). This article does not identify any extraordinary safety requirements for the use and handling of large quantities hydrogen in an industrial environment. Reider and Edeskuty (1991) state that "The accident experience with hydrogen, other than its use in lighter-than-air craft, has not been inordinately worse that the accident experience with more commonly used fuels." NASA has documented accidents and incidents with its use of large quantities of liquid hydrogen in Ordin (1974). This article states that, "The records do, however, indicate a very high level of safety with hydrogen." Of the mishaps identified by NASA, only half the hydrogen releases to the atmosphere resulted in ignition. Hydrogen releases to enclosures had an even lower ignition rate of 25% (Ordin, 1974). The majority of the NASA mishaps resulted from operational and procedural errors (Ordin, 1974). Track record for other applications is not vastly different. Large amounts of liquid hydrogen were also used in the NERVA program and the safety hazards have been documented (Reider and Edeskuty, 1976; Edeskuty, 1964). Industrial experience with hydrogen accidents in the period 1965-1977 has been assembled (Zalosh and Short, 1978). Other general references on hydrogen safety are (Chelton, 1964; Edeskuty and Reider, 1969; Roven, et al., 1970; Hord, 1976, Suaniere and Tellier, 1983; DOE, 1990f; DoD, 1991; Edeskuty, 1991).

(U) Hazards: The main hazard in the use of hydrogen relates to combustion. Hydrogen will burn in air over a very wide range of hydrogen-air composition and is easily ignited. Deflagration-to-detonation transition of hydrogen-air mixtures is possible over a wide range of composition (4-75% hydrogen) if there are flame acceleration promoters (obstacle generated turbulence, fast hot jets, etc.) (Sherman, et al., 1985; Sherman et al., 1989; Tieszen, et al., 1987). Hydrogen exiting from leaks from hydrogen storage or supply systems into air will form a diffusion (unpremixed) flame if there is an ignition source. A unique hazard associated with these flames is that they burn with a pale blue flame that is nearly invisible to the naked eye in daylight. Hydrogen embrittlement of metals and the hazards common in the use of high pressure gases need to be considered in any design of a hydrogen system.

(U) The use of liquid hydrogen introduces additional hazards. The selected condensation of air can enrich the local oxygen content increasing the possible violence of hydrogen burns. If the system is not purged of air, oxygen crystals can be formed in the liquid hydrogen, and liquid hydrogen-solid oxygen can form a detonable mass. There must be provision for venting in any potential fixed volume where liquid hydrogen, or even cold gaseous hydrogen, might collect. If trapped in a fixed volume, the pressure buildup as heat enters can rupture the system. At the cryogenic temperatures of liquid hydrogen the materials used must be carefully selected to ensure adequate performance at these low temperatures.

(U) Regulations: Hord (1978) has compiled an annotated bibliography of regulations, standards and guidelines for hydrogen safety. The relevant CFR documents are included in this list of 79 references. All relevant regulations, standards and guidelines for hydrogen safety included in this list of 79 references would be met by the final design of the ground test facility. Of the references cited, particular note is given to the NFPA Pamphlet No. 50A for gaseous hydrogen, NFPA 50B for liquid hydrogen, and CGA Pamphlet G-5 for hydrogen. These documents have provided the basis for hydrogen safety and handling for the ground test facility design. Air Force regulation 127-100 (USAF, 1990) is a more general reference of "Explosive Safety Hazards" with some relevance to hydrogen safety standards. This regulation has also influenced the facility design. Facility structural design considerations are presented in DoD (1969). These referenced standards, as supplemented by available safe handling procedures published by facilities currently handling significant quantities of hydrogen, would form the basis for developing site specific safe handling procedures.

(U) Facility Protection: A number of features have been incorporated into the facility design to reduce the potential safety and environmental impacts of storing and using large quantities of hydrogen. These features are described in Section 2.3.2.2.1.3.1. Several of these features are of particular note and are discussed below.

(U) The general facility layout is intended to enhance hydrogen safety. All hydrogen storage would be in a concentrated area on grade below that of the other structures of the facility. A ridge separates the bulk hydrogen storage from the test cells. The other facility structures (control bunker, receiving/assembly building, disassembly building, etc.) would be uphill from the storage area. Any liquid hydrogen leak would drain away from the other facility structures. The facility structures would be protected from pressure pulses and projectiles that might result from detonations and/or deflagrations in the hydrogen storage areas by both the natural earth barriers that result from the facility layout and by shrapnel barriers. Shrapnel barriers are incorporated into the facility design to preclude lines of sight between the hydrogen storage area and the facility structures and populated areas.

(U) All components in the process fluids system (CSS and ETS) would be welded in place to the maximum extent possible to minimize the potential for hydrogen leaks. At locations where leaks may occur (flanged fittings, valves, pumps, etc.) appropriate leak and fire detection and fire protection would be incorporated into the system design. Pressure relief would be incorporated into any component or piping run that may carry cryogenic hydrogen and be isolated. This would protect these components from overpressure and potential rupture should cryogenic hydrogen become trapped in them and warm up.

(U) The process fluids system is being designed to allow purging procedures to ensure that no combustionable mixtures would result when hydrogen is introduced into a line or component. Any structures that have the potential to accumulate hydrogen would be either inerted or ventilated with sufficient qualities of fresh air to ensure that no combustible mixtures would occur. Avoiding hydrogen accumulation is a major consideration in the facility design.

(U) Open air detonation of hydrogen could expose the facility structures to various degrees of overpressure. All significant quantities of hydrogen released to the atmosphere during normal

operations of the facility would be flared so that large quantities of hydrogen do not accumulate in the vicinity of the facility.

(U) A major hydrogen leak could result in a potential risk to the facility. The overpressures resulting from detonations can be estimated (Sherman, 1985; Tieszen, et al., 1987; Sherman, et al., 198). Overpressure estimates resulting from appropriate off-normal operating conditions would be incorporated into the facility design to minimize any damage to the structures and ensure protection of the test articles and other critical components.

(U) It should be noted that the facility accident cases considered to date have assumed 100% release of the radionuclide content of the article being tested. This bounding case is independent of the initiating event. Thus, no hydrogen accident could result in a source term greater than for the cases analyzed, i.e., the radiological consequences of hydrogen accidents are bounded by the maximum hypothetical accident already considered. Furthermore, the experience with hydrogen handling in the U.S. described earlier has demonstrated that the probabilities of hydrogen accidents causing severe damage can be made very low by the proper use of applicable design guides and safety standards.

(U) The potential releases from other radioactive materials stored on-site would always be much less than the test article inventory analyzed. The only other irradiated and by-product materials stored on-site would be long-cooled test articles or elements in the below-grade temporary storage area or the thick-walled disassembly building. The probability that these areas would be damaged simultaneously with the test article is extremely low given the physical separation and hydrogen safety considerations applied to the overall facility design and operation.

(U) The Final Safety Analysis Report will include a probability risk assessment of the nuclear hazard associated with hydrogen burns and explosions.

(U) Nonradiological Consequences of Hydrogen Operations: Hydrogen represents an industrial safety hazard for on-site workers that is equivalent to combustible or cryogenic fluid operations at other sites and that is not unique to this operation. Hydrogen, both liquid and gaseous, is routinely handled at a number of NASA, DoD, private industry, and non-profit research centers around the United States. The remoteness of all sites being considered for this program precludes non-radiological impacts from hydrogen accidents significantly affecting people or property off-site.

Industrial Safety (U)

(U) Review of accident data published by the Department of Labor (DOL), Bureau of Labor Statistics (BLS), indicates that in 1989 industrial safety in the aerospace industry was significantly better than the average of all manufacturing activities. Aerospace industry experienced approximately one-half of the lost work days as does the manufacturing industry as a whole (Horan, 1991c).

2.4.4 [redacted] Test Safety (U)

([redacted]) Although the decision to perform [redacted]

2.4.4.1 General Issues (U)

([redacted]) Nuclear safety requirements would be incorporated in the [redacted] design, the power system design, and operational characteristics.

(U) System design safety requirements would include the following:

- (U) Reactivity control -- the reactivity control system would be capable of escalating the reactor to full power or reducing the reactor from full power to a subcritical state.

- (U) Instrumentation -- the [redacted] instrumentation system would permit continuous ground monitoring of reactor performance including reactor power levels and rate of change; control element position; coolant flow rate and temperature at reactor inlet; coolant exit temperature; and the status of the reactivity control system, the reactor shutdown system, and the redundant actuator power sources. Each redundant element would also be monitored.

- (U) Automatic reactor shutdown -- the reactor automatic shutdown system would use two independent methods of achieving and maintaining subcriticality; be capable of sensing conditions calling for shutdown and automatically shutting down the reactor in event of failure of the reactor control system, excessive coolant outlet temperature, loss of electrical power, demand for SCRAM (automated shutdown) [redacted], or excessive neutron flux; and not be subject to common cause failure.

(U) All reactor systems would be designed, analyzed, and reviewed through the nuclear Safety Analysis Report with acceptable[1] margins of safety and without loss of capability to perform their intended safety functions in all environments encountered during storage, handling, maintenance, testing, [redacted]. These environments include: humidity, vibration, shock, acceleration, acoustic noise, overpressure, temperature, potential shrapnel impacts and radiation.

([redacted]) Operational safety requirements would preclude [redacted].

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[1](U) "Acceptable" is a qualitative description that implies that all components would be designed with a degree of robustness compatible with practical considerations. These considerations include the scope of effort required to improve the margin of safety, impact on the overall vehicle characteristics, and the net advantage accrued by implementing the improvement. The quantitative margin of safety would vary from component to component.

[redacted]

2.4.4.2 Prevention of Inadvertent Criticality (U)

([redacted]) In order to assure safety and protection of the environment, it is necessary to positively prevent the reactor from becoming critical prior to the moment intended, and to positively assure that criticality can be effectively terminated. This requirement applies under all conditions resulting from accident or equipment malfunctions, [redacted]

[redacted]

([redacted]) To keep the reactor from becoming critical [redacted], a set of "poison rods" (rods which are composed of neutron absorbing material, principally boron) could be inserted into the reactor hot gas channel. The rods would remain in the reactor until they are extracted [redacted].

(U) These rods would positively inhibit reactor criticality by absorbing any excess neutrons that may result from changes in reactor geometry caused by [redacted], or deformations resulting from fire, and by preventing increase in reactivity due to change in moderator characteristics caused by intrusion of fluids as a result of [redacted].

(U) The rods are in addition to, and entirely separate and distinct from the reactor safety SCRAM system, which can positively turn off the reactor and the reactor control system, which controls reactor power level.

Initiation (U)

([redacted]) [redacted]

([redacted]) [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

2.5 ALTERNATIVES TO THE PROPOSED ACTION (U)

([redacted]) Only the no action alternative is an alternative to the proposed action. The no action alternative is that the [redacted] would not carry forward with the [redacted] program. Component assembly and fabrication, and ground testing would not be carried forward,. The no action alternative would not develop and demonstrate the PBR propelled rocket technology.

2.6 ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD (U)

(U) The following alternatives were considered but not carried forward,:

2.6.1 Alternative Fuel (U)

([redacted]) Any material to be considered as an alternate fuel for the PBR engine would have to be either fissionable or fertile. The only potential candidates which meet this criteria are all isotopes of thorium (Th), uranium (U), plutonium (Pu), or Californium (Cf). To be further considered, the material must be available from an existing manufacturing process, capable of surviving high temperatures, require minimum weights to achieve criticality, and minimize the impact to the environment resulting from either manufacturing or utilization. Thorium was rejected as a candidate material because it would require a mass which exceeds the maximum weight requirements for the PBR engine; plutonium was rejected due to the [redacted] health risk associated with its use; and Californium was rejected because of its non-availability.

([redacted]) Only uranium remains as a candidate material. Two uranium isotopes were considered, U-233 and U-235. Traditionally, reactors requiring fast response times have used fully enriched U-235 as the basic fuel form. Uranium-233 introduces both a significant negative fuel temperature coefficient due in part to doppler broadening of the resonance escape peaks and a longer neutron lifetime which results in a slower system requiring a larger quantity of fuel material than a comparable U-235 system. Currently operating fuel manufacturing processes are capable of providing uranium-233 in very limited quantities. Increasing U-233 production would also increase the quantity of waste products associated with fuel production, compounding an existing adverse environmental situation. The proposed current U-235 fuel form, which is available from existing stockpiles, provides the maximum system performance while minimizing potentially negative environmental impacts.

2.6.2 Alternative Propellant (U)

([redacted]) One alternative considered but not carried forward, would be to use helium rather than hydrogen as the propellant. Because helium has larger atoms than hydrogen, its use would necessitate increasing the size of the fuel pellets to allow free passage of the helium through them; otherwise a pressure drop would be created across the cold frit that would exceed its structural capacity. Increasing the size of the fuel pellets would reduce the surface to volume ratio and decrease the potential Isp of the rocket. The use of helium as a propellant would result in an Isp that is about 70 percent of that for hydrogen (Hill and Peterson, 1970) and would not accomplish the [redacted]. [Even if the lower Isp were acceptable, helium would require storage and handling at temperatures of approximately 4 K (-270° C), a significant increase in complexity over the storage requirements of hydrogen at 25 K (-250° C)].

2.6.3 Materials and Components Testing Alternatives (U)

2.6.3.1 Simulation of Testing and Operating Conditions (U)

(U) Another alternative considered but not carried forward, would be the simulation of testing and operating conditions in place of physical testing. The performance of materials, components, assemblies and [redacted] could be simulated by computer codes. Significant simulation is presently included in the [redacted] program and extending this effort would be possible. Simulation of testing and operating conditions does not allow validation of component performance [redacted]. Eliminating physical testing decreases the chance of the program's success.

2.6.3.2 Integrated Bench Scale Tests (U)

([redacted]) Another alternative considered but not carried forward, would be to perform bench scale tests that incorporate PBR technology, fluid management and ETS to provide a cost effective validation of the system prior to testing at the sub-scale facility. The use of this alternative to develop the PBR technology would not fully demonstrate the viability of the system [redacted].

2.6.3.3 Continued R&D of Components and Assemblies (U)

(U) Another alternative considered but not carried forward, is to continue research and development of the rocket components and assemblies until more data is available on the new technologies being developed for [redacted]. This would extend the schedule without moving toward meeting the objectives of the [redacted] program.

2.6.3.4 Water Injection Cooling of Effluent Stream (U)

(U) One alternative considered but not carried forward, is to cool the ETS effluent stream with water injection. Due to the high heat of vaporization of water, this concept showed potential for being an efficient cooling option. However, water cooling greatly increases the complexity of the overall system. During normal operations, this concept would require tens of thousands of gallons of water to be used to cool the effluent stream. There is the potential for this entire ETS water supply being contaminated. All removed water [approximately 3,800,000 liters (1,000,000 gal)] would be required to be analyzed for radioactive materials and hazardous waste constituents. An additional potential difficulty with water injection is that large energy releases may occur from chemical reactions of water with debris (primarily Al and Be) that may enter the ETS during some postulated test article failure modes. Because of the complexity added to the system as well as the large volume of low-level liquid wastes that could potentially have to be disposed, water injection was rejected as an effluent cooling alternative.

2.6.4 Ground Test Modifications (U)

2.6.4.1 Extend Intervals Between Tests (U)

(U) Another alternative to the development and testing program as proposed would be to extend the time interval between tests to reduce the impact of the radiological dose from the ground testing by allowing time for radiological decay of the fission products. This would intuitively appear to offer two benefits. First, the total fission product which could potentially be released in an accident would be reduced. Second, the average annual radiation fraction release would be reduced.

(U) However, a study (described in detail in Section 4.7) showed that most fission product decay would occur within one day of each test. Greater intervals than those proposed do not reduce radiological doses or improve safety to any appreciable degree.

2.6.4.2 Engine Integration Test (EIT) Performed at Alternate Location (U)

(U) One alternative considered but not carried forward, would be for the non-nuclear components of the engine to be completely integrated at the test station or partially assembled and tested at alternate locations and shipped to the ground test facility and mated with the PBR for GTA or QTA. The EIT could be performed prior to delivery of the system to the ground test facility. This alternative would increase the risk of damage to the engine during transportation without an offsetting decrease in environmental impacts from alternate site testing.

2.6.4.3 No or Partial Engine Integration Test (EIT) (U)

(U) Other alternatives considered but not carried forward, include testing the individual components only without performing an engine integration test or performing a combination of component testing and partial integration. These alternatives would not fully demonstrate the integrity of the engine components prior to the GTA and QTA tests, increasing the probability of project failure.

2.6.4.4 No PIPET (U)

(U) Another alternative considered but not carried forward, would be to eliminate the PIPET tests. Such a measure would eliminate the potential dangers associated with this test, but would increase the uncertainties and dangers associated with the subsequent ground tests (GTA and QTA). This alternative lacks an effective demonstration program which would ensure the success of the program.

2.6.4.5 Long Duration Runs at Lower Power Levels (U)

([redacted]) Another alternative considered but not carried forward, is to conduct longer duration ground tests at reduced power levels. For example 4-5 hour tests at 2300 K (2030° C) could be conducted. Such tests have already been conducted for other applications. The [redacted] program requires the development of a propellant system that generates extremely high temperatures [i.e.

[redacted] for short durations. Long duration runs at lower power levels would not demonstrate the integrity of the PBR system at [redacted] temperatures.

2.6.4.6 No Ground Testing of PBR Engine ([redacted])

(U) Another alternative considered but not carried forward, would be to eliminate the ground testing completely. It is theoretically possible to conduct a rocket engine development program without recourse to ground testing. However, the objective of a development program and the history of actual programs argue strongly for a comprehensive ground test activity to be an integral part of any new [redacted].

(U) The history of engine development programs shows that component and system failures are frequently encountered. Failures impose penalties and may put successful development in doubt. Beyond the development issues associated with typical rocket engines, this program introduces new considerations in regard to the effect of possible failures on radiological safety and protection of the environment. These considerations strengthen the rationale for comprehensive ground testing.

(U) Ground testing permits progressive build-up of the test article and progressive expansion of the test envelope. Initially, the test article can be a simple assemblage of a limited number of system components, which is tested at low stress levels. From this starting point, an incremental series of tests are conducted which confirm satisfactory operation, develop confidence in the system, and allow testing to progress to more complex levels of assembly at more severe stress levels, culminating in the full system configuration at full mission levels.

([redacted]) The proposed ground testing activities that support the [redacted] program provide a means of demonstrating PBR technology in several distinct phases which progress from testing the individual fuel element to operating a prototypical QTA.

([redacted]) Elimination of the ground test activities would result in placing a completely new nuclear thermal propulsion technology into [redacted] the following:

1) (U) Performance of the PBR fuel material at prototypic operating parameters including reactivity worth, fuel temperature, pressure, reactor power density, and full power operating durations.

2) (U) Adequate safety margins from which the maximum safe operating envelopes can be determined without destructive testing.

3) (U) The ability of the automated digital control algorithms to control the reactor.

4) (U) The ability to cool the neutron moderating material.

(U) Eliminating ground testing would decrease the chances of a successful [redacted].

2.6.5 Alternative Propulsion System (U)

2.6.5.1 Chemical Fueled Vehicle (U)

([redacted]) Another alternative considered but not carried forward, is to power [redacted] with chemical fuels only. A chemical fueled rocket of similar size to that powered by the PBR engine would have only one-half to one-third of its specific impulse. [redacted]. Even when scaled to very large sizes, chemical fueled rockets cannot achieve the performance of a [redacted] rocket (Grumman, 1990).

2.6.5.2 Alternative Nuclear Propulsion System (U)

([redacted]) Another alternative considered but not carried forward, is the use of alternative nuclear propulsion system concepts for [redacted]. Other nuclear thermal propulsion concepts being considered may have comparable Isp, however, only the PBR concept can also provide the high thrust-to-weight ratio needed for [redacted].

2.7 ALTERNATIVE GROUND TEST LOCATIONS (U)

([redacted]) Three separate sites at two major DOE installations have been identified as meeting the exclusionary criteria. These sites are the Saddle Mountain site at the Nevada Test Site (NTS) and the QUEST and LOFT sites at Idaho National Engineering Laboratory (INEL). These sites meet the principal exclusionary criteria required: (1) similar nuclear activities program to screen the PBR activities, (2) 15 km (9 mi) distance to the nearest urban area, and (3) federal ownership of the facility. Both of the DOE installations have considerable infrastructure support but the Saddle Mountain and QUEST sites would require new construction for all ground test facilities while the LOFT site would provide existing infrastructure but require modifications to existing facilities as well as some new construction. All three sites would require maintenance, testing, waste management, and ultimate disposition or decontamination of the test facility (THG, 1991). A description of the site selection process is provided in Appendix C.

2.7.1 Saddle Mountain Test Station (SMTS) - Nevada Test Site (NTS) (U)

(U) The preferred site for the ground test facility is the Saddle Mountain site [which will be henceforth referred to as the Saddle Mountain Test Station (SMTS)] of the Nevada Test Site (NTS). The location of the SMTS is shown in Figure 2.7-1. The principle reasons for preference of this site include remoteness (i.e. no nearby activities), seclusion of the site location (ease of controlling access), distance to the site boundaries (essentially equidistant N-S and E-W), integrated emergency response capability, and favorable topography.

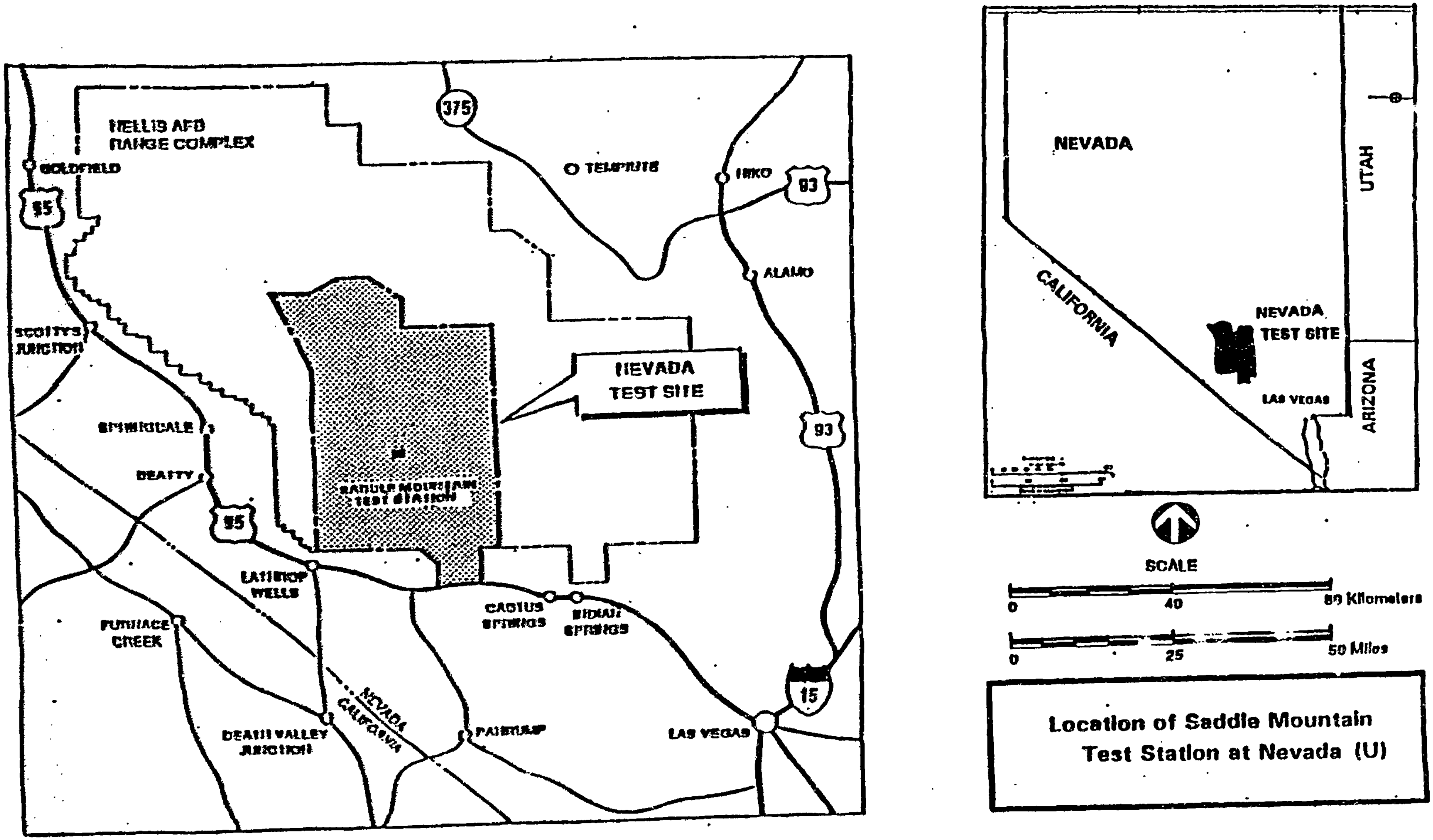
(U) The facility is proposed to be constructed in the northwest section of Area 14 in the Nevada Test Site, south of Mine Mountain Road and west of the Saddle Mountain Road. Distances to the NTS boundaries are: north 34 km (22 mi), south 30 km (19 mi), east 23 km (14 mi) and west 23 km (14 mi). Access to the test area, Shoshone Transmitter and Receiver sites and the balance of Area 14 is controlled by the Nevada Test Security Branch of the Nevada Operations Office Safeguards and Security Division (SNL, 1990b).

(U) Selection of the SMTS would require new construction for sub-scale and full-scale test facilities. These facilities are described in Section 2.3.2.2. Other infrastructure required for the site include power lines, phone lines, roads, a deep water well, water storage tanks, and roads.

<u>Power and Telephone Lines</u> (U)

(U) An approximately 4-km (2.4-mi) long power transmission line would be required to connect the facility to the existing power lines. The installation of a stepdown transformer would also be required. An approximately 3-km (2-mi) long phone line would be required to tap into the existing phone lines. Additional power capacity may be needed for the SMTS. This power may be available by upgrading the NTS power grid but present plans assume large but transportable generators to be located at the SMTS. Since peak power is required for a few hours for each test, the total energy generated and emissions produced by diesel motor generators would be so small that air quality permits would not be required.

[redacted]



Location of Saddle Mountain
Test Station at Nevada (U)

Figure 2.7-1 (U)

[redacted]

Roads (U)

(U) Three gravel roads are required: a 900 m (3,000 ft) entrance access road, a 700 m (2,300 ft) water tank access road, and a circular loop road surfaced with oil. The portion of that road near the test cell would include a reinforced concrete working surface designed to accommodate loads up to 70,000 kg (80 tons). Approximately 4,200 m^3 (5,500 yd^3) of material would be excavated to accommodate the roads. Existing secondary roads would also be widened.

Sanitary System (U)

(U) A sanitary system would be required for the peak 50-60 person on-site staff during test preparation. The most appropriate system for the site would be a septic tank which drains into a leach field. It is anticipated that less than 19,000 liters per day (5,000 gal/day) of sanitary waste would be produced.

Water Supply (U)

(U) Water would be provided from an existing 1,120 meter (3,680 ft) deep, large diameter exploratory drill hole located near the axis of Mid-Valley, about 3.5 km (2.1 mi) southeast of the SMTS. The well is not used for water supply purposes for any other activities at NTS. Pumping depth would be at about 610 meters (2000 ft) below the surface. For construction and the subscale tests, a PVC water supply line would be laid on the ground surface to the SMTS and a portable generator would be used to supply power to the pump. For the full-scale systems tests, consideration would be given to constructing a 2.5-km (1.5-mi) buried waterline and installing a new 4-km (2.4-mi) long power line from the exiting line along Mine Mountain Road. Wellhead development would consist mainly of laying a 12 x 12 meter (40 x 40 ft) concrete pad and installing necessary piping, valves, and meters. Access to the wellhead is by an existing unimproved road. Water would be stored in two 945,000 liter (250,000 gal) storage tanks which would be placed in an elevated area of the site.

Disturbed Area (U)

(U) Construction of the test facility would require earth removal and fill for the [redacted] test site and water tank installation and grading for the roads. The cut and fill required are approximately 28,000 m^3 (36,000 yd^3) and 20,000 m^3 (26,000 yd^3) respectively. The total area impacted at the Saddle Mountain Test Station is anticipated to be less than 40 hectares (100 acres).

2.7.2 Idaho National Engineering Laboratory (INEL) (U)

([redacted]) Two sites within the Idaho National Engineering Laboratory (INEL) are also being considered for the ground test facility. INEL, located in the southeastern part of Idaho, has the support facilities for nuclear reactor testing. Over the past 35 years a total of 52 reactors have been operated there. The locations of the two sites, QUEST and LOFT, are shown in Figure 2.7-2.

[redacted]

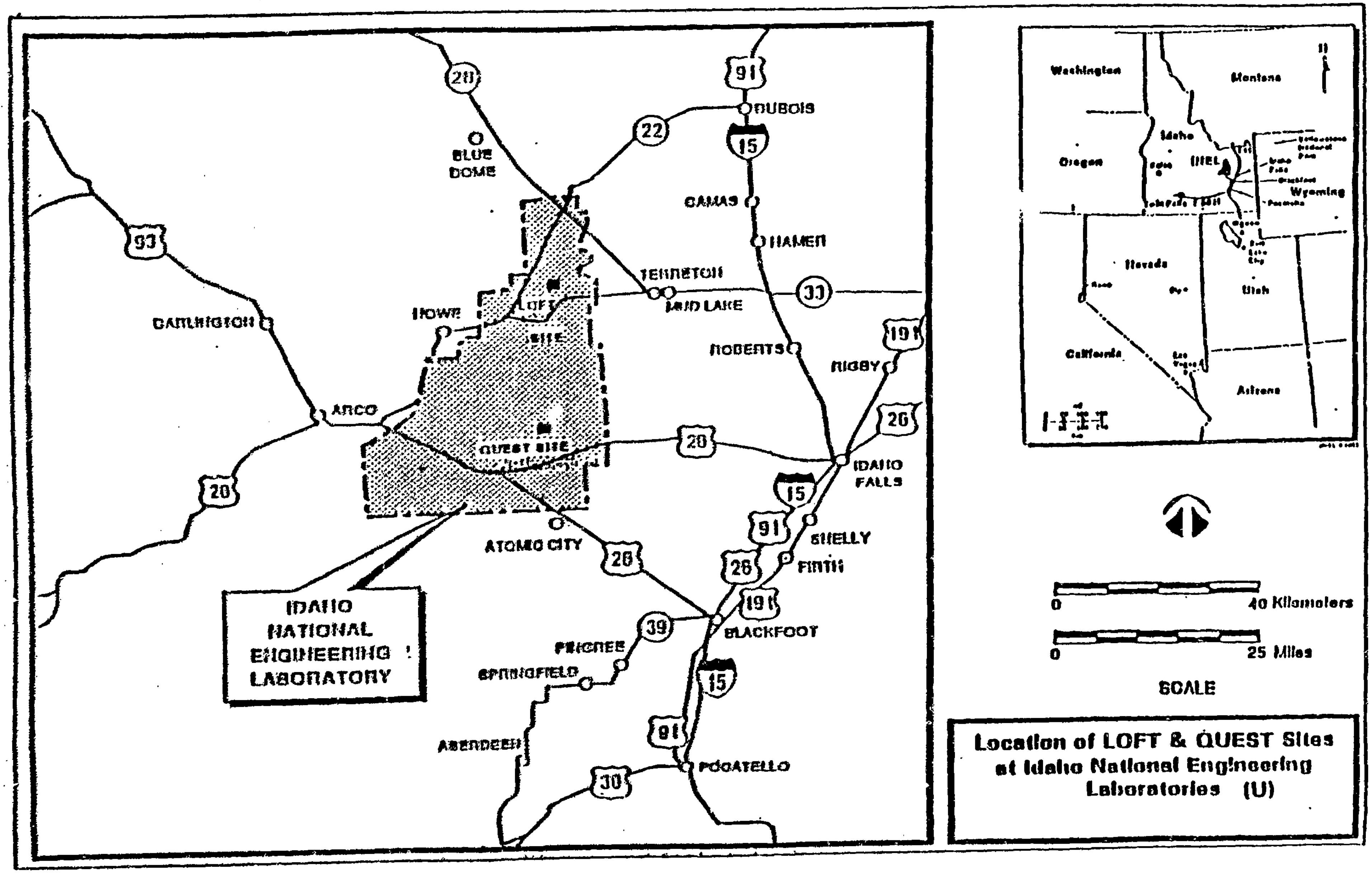


Figure 2.7-2 (U)

[redacted]

2.7.2.1 QUEST Site - Idaho National Engineering Laboratory (INEL) (U)

(U) Distance from the QUEST site to the INEL boundaries are: north 38 km (23 mi), south 27 km (17 mi), east 16 km (10 mi) and west 30 km (19 mi).

(U) The facilities requirements for the QUEST site are similar in many respects to the SMTS site. This site would also require the construction of a sub-scale and full-scale test facility (as described in Section 2.3.2.2). There are some differences, however, in the types of infrastructure required:

Power and Telephone Lines (U)

(U) Approximately 1.2 km (0.7 mi) of new power transmission lines and 9.2 km (5.5 mi) of new telecommunication lines would be required to connect the proposed location to the existing utilities. The construction of a switch and substation would also be required.

Roads (U)

(U) An approximately 5 km (3 mi) gravel road would be required to connect the QUEST site to the existing roadways. Onsite gravel roads would include approximately 1.7 km (1.0 mi) for an entrance access road, a water tank access road, and a water well access road. The portion of that road near the test cell would include a reinforced concrete working surface designed to accommodate loads up to 70,000 kg (80 tons). Approximately 5,000 m^3 (6,500 yd^3) of material would be excavated to accommodate the roads.

Sanitary System (U)

(U) A sanitary system similar to that required for the SMTS would have to be constructed at the QUEST site.

Water Supply (U)

(U) An approximately 140-m (450-ft) deep well would be required to provide water to the site. The water would be stored in two 945,000 liter (250,000 gal) storage tanks. A water rights agreement signed with the Idaho State Water Resources Board allots INEL 2.3 m^3/s (82 cfs).

Disturbed Area (U)

(U) Construction of the test facility would require earth removal and fill of about 25,000-30,000 m^3 (33,000-39,000 yd^3) for the [redacted] test site and water tank installation and grading for the roads. The total area impacted at the QUEST Site is anticipated to be about the same as the area at the SMTS: less than 40 hectares (100 acres). In addition, about 8 hectares (20 acres) would be disturbed for construction of the access road.

2.7.2.2 LOFT Site - Idaho National Engineering Laboratory (INEL) (U)

(U) Existing facilities to support the [redacted] program are already located at the LOFT site at INEL. Approximate distances to the INEL boundaries are: north 18 km (11 mi), south 45 km (28 mi), east 17 km (11 mi) and west 13 km (8 mi).

(U) The existing facilities at the LOFT site consist of a receiving/assembly/hot cell facility, a certified ASME pressure vessel (containment structure), a control bunker, PIE facilities, and administrative space. An approximately 2.6 km (1.6 mi) railroad track connects the containment structure to the receiving/assembly/hot cell facility. A security fence with guard stations is also in place.

(S) A number of modifications would be required to the existing facility. It is likely that the control building would have to be reconfigured to accommodate the [redacted] tests. The receiving/assembly/hot cell facility may require modest modification to accommodate the hot test articles as required.

(U) Use of the LOFT containment structure as the test cell would require construction of process fluids storage and piping, the ETS, and the flare stack near the pressure vessel. The test article would be secured to one of the special rail cars moved to the LOFT containment structure and connected to coolant fluids and the ETS. Following the test and after a cool-down period, the test article could be moved directly to the hot-cell facility for disassembly and post irradiation examination. Adaptation of the LOFT vessel to provide for coolant flow, debris collection, exhaust of propellant and purging, inerting and venting has not been defined. If safety requirements include significant modification, cost savings would be offset by the cost of modifications.

(U) Infrastructure required for the [redacted] activities are already in place at the site. These include paved roads, power lines, telephone lines, a sanitary system, and a water supply.

<u>Disturbed Area</u> (U)

(U) (U) Modification and construction of the test facility would affect less than 20 hectares (50 acres) of previously disturbed land adjacent to the containment structure. Cut and fill requirements are approximately 2,500-3,000 m^3 (3,000-4,000 yd^3).

2.8 ENVIRONMENTAL CONSEQUENCES OF PROGRAMMATIC ALTERNATIVES (U)

(U) The following section discusses the environmental consequences associated with the proposed action and the no action alternative. This section is intended to give the reader an overview of the environmental effects associated with each alternative; a more complete understanding of these issues may be gained by reading Chapters 3 and 4.

([redacted]) The [redacted] program, like any new technological program, contains inherent elements of uncertainty. Consequently, the potential programmatic impacts emanating from the program also contain a degree of uncertainty. Four actions have been taken to reduce the uncertainty associated with the potential [redacted] program impacts. First, the resources of the most qualified experts in many fields have been and would continue to be involved in the research program. This includes experts in the fields of nuclear sciences, aerospace engineering, and materials development, among others. Second, the developmental program is a step-by-step process that ensures the integrity and soundness of each step of the program before proceeding to the next step. Third, safety analyses are performed for each aspect of the testing, including material and component testing, ground testing, and flight testing. And fourth, conservative assumptions are used in all analyses.

([redacted]) The issues compared here are only those in which the potential intensity of the environmental impact have been found to be low, moderate, or high as a result of the proposed action (See Appendix D for intensity criteria). In each case, mitigative measures would be applied to the impacts to reduce them to insignificant levels. It is therefore possible to have a high level of impact intensity that would result in insignificant environmental consequences because of the context of the impacts or as a result of the implementation of mitigation measures. For example, noise would reach high levels of impact intensity, but the environmental consequences would be insignificant because of context and mitigation. Specifically, the general public would be far beyond the area of noise impacts and potential impacts to the few workers during testing would be mitigated by their enclosure in a control bunker and the required use of protective safety equipment. Radiological consequences are also addressed due to the specific nature of the [redacted] program. Consideration of these impacts and mitigations in their full context has led to the determination that the [redacted] program would have insignificant environmental consequences.

2.8.1 Land Use and Infrastructure (U)

(U) Programmatic impacts upon land use and infrastructure from the operation of the ground test facility would be low. It is possible that some highways would be temporarily closed during testing, but traffic volumes are expected to be low on these highways; testing is infrequent and durations are short so that impacts are low and environmental consequences are insignificant.

(U) The no action alternative would not produce any land use or infrastructure-related impacts.

2.8.2 Noise (U)

(U) Noise impacts would have the potential to be high as a result of the proposed action. Noise could be raised above short-term (15 min.) and long-term (8 hour) OSHA limits by more than 35 dBA by the operation of heavy equipment during the [redacted] facility construction and during testing, requiring mitigation for the work force. Mitigation measures would probably be required for short periods (several minutes) during testing activities. All noise impacts are localized to an area within a 5 km (3 miles) radius of construction and testing, hence no impacts to the public or sensitive receptors would be realized. Although noise impacts would be high and environmental consequences potentially significant at the test site, they would be mitigated to insignificant levels as discussed in Chapter 4.

(U) The no action alternative would not produce noise-related impacts.

2.8.3 Cultural Resources (U)

(U) Cultural resource surveys would be conducted for any area not previously surveyed and the appropriate State Historic Preservation Officer would be contacted prior to conducting any [redacted] program activities. If site specific cultural resources are found to be potentially impacted, appropriate measures would be taken to reduce the environmental consequences to insignificant levels. These measures would include 1) identification and recovery of artifacts; 2) relocation of facilities; and 3) flagging of sites to be left undisturbed. This would ensure that potential programmatic impacts to cultural resources would be low and would result in insignificant environmental consequences.

(U) The no action alternative produces no disturbance to cultural resources and hence causes no impacts.

2.8.4 Safety (U)

(U) Impacts from the proposed action on non-radiological aspects of occupational safety would be moderate, but would not exceed OSHA or DOE standards. The greatest impact potential would be from accidents involving the handling and storage of hydrogen, oxygen, and helium. Mitigative measures are incorporated into the proposed action to minimize this potential. They include extensive training and precautionary measures for the occupational work force to greatly reduce the probability of an accident as well as the inclusion of safety design features of the facility. Although potential impacts on safety would be moderate and environmental consequences potentially significant, they would be mitigated to insignificant levels as discussed.

(U) The no action alternative does not involve construction and operation of the [redacted] facility and therefore would not expose the labor force or members of the general public to any accident hazards.

[redacted]

2.8.5 Waste (U)

(S) It is projected that all low-level radiological waste would be managed at the installation where the waste is generated. The impact from waste would be low at QUEST and LOFT and negligible at SMTS. Impacts from RCRA-regulated hazardous waste and any mixed and TRU wastes generated by [redacted] program activities would have negligible impacts since they would be handled within existing process streams. Since the wastes generated by the [redacted] program would be managed in accordance with existing waste management procedures which include protection of the environment, impacts would be negligible to low and the environmental consequences would be insignificant.

(U) The no action alternative produces no such wastes and hence causes no impacts.

2.8.6 Radiological Impacts (U)

<u>Normal Operations</u> (U)

(U) The calculations of the human exposure to low levels of radiation are predicted by the MACCS model developed for the U.S. Nuclear Regulatory Commission. This model is an accepted method for predicting radiological impacts from radiological releases. The model depends upon a set of "program model conditions" which include assumptions of fuel particle integrity, test run times and power levels, ETS performance and meteorological conditions[1]. (These program model conditions are described fully in Section 4.3.4.)

(U) <u>Maximally Exposed Individual:</u> The program model conditions would result in a radiological dose from normal operations to a hypothetical "maximally exposed individual" which would be well below NESHAP standards. Modeling of the dose effect upon the maximally exposed individual indicates that the estimated additional risk of cancer deaths and genetic disorders to the individual are sufficiently small that no health effects are expected to occur from radiation exposure at the program model conditions. These impacts are considered negligible and would result in insignificant environmental consequences.

(U) Adoption of the no action alternative would result in no impact.

(U) <u>Population:</u> The program model conditions from normal operations would result in a radiological dose to the population downwind of a ground testing facility from normal operations. Population dose would be controlled by limiting program operations to times of favorable wind speed and direction. The health-related consequences to this population, however, indicate that the estimated increase in cancer deaths and genetic disorders are sufficiently small that no health effects are expected to occur as a result of normal operations and impacts would be considered negligible. In this context of regulatory compliance and negligible impacts to public health, the environmental consequences would be insignificant.

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[1](U) Various meteorological conditions would disperse effluents with varying time and distribution.

[redacted]

(U) The no action alternative would not result in any radiological impacts to the population downwind of a testing facility.

Bounding Case Accident Scenario (U)

(U) Calculations of the impacts of radiological doses resulting from the hypothetical bounding case accident scenario under program model conditions were determined by the MACCS model. This hypothetical bounding case accident assumes the release of the total isotope inventory. The design base accident would be determined during the safety analysis process and would be some fraction of the hypothetical bounding case. Such an accident could only occur during test activities. There is no risk of the bounding case accident between the test periods.

(U) Maximally Exposed Individual: The hypothetical bounding case accident scenario would result in a dose to a maximally exposed individual which would not exceed applicable ANSI/ANS 15.7 accident standards. Resultant health effects estimates indicate that the estimated increased risk of cancer deaths and genetic disorders to the individual are sufficiently small that no health effects are expected to occur. The environmental consequences for the maximally exposed individual would be insignificant.

(U) The no action alternative would cause no radiological impacts.

(U) Population: Impacts to the health of the population 80 km (50 mi) downwind of a hypothetical bounding case accident indicate that the estimated increase in cancer deaths and genetic disorders are sufficiently small that no health effects are expected to occur. These impacts are considered negligible. Compliance with regulatory requirements for individual dose and public health impacts at minimal levels would result in insignificant environmental consequences.

(U) Adoption of the no action alternative would create no radiological impacts.

2.8.7 Radiological Impact Variables (U)

(U) The safety and environmental impacts of radioactive releases are based on a number of factors which directly affect the exposure to site workers, installation workers, and members of the general public. Based on the best available information, including conservative engineering judgements of fuel particle and fuel element characteristics, ETS design, required run time and power levels, and modeled meteorological conditions, all applicable standards are shown to be met. The analysis indicates that potential radiological impacts are well within applicable standards when meteorological conditions include a wind speed of 5.5 meters per second (18 fps), atmosphere stability Class D[2], and an inversion level of 2,000 meters (6,600 ft).

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[2](U) Pasquill stability classes (also termed atmospheric stability classes) are measures of relative turbulence. There are six categories of stability classes, A through F: A (extremely unstable), B (moderately unstable), C (slightly unstable), D (neutral), E (slightly stable), and F (moderately stable).

[redacted]

([redacted]) The safety and environmental impact of radioactive releases are based on a number of factors which directly affect the exposure to site workers, installation workers, and members of the general public. Based on the best available meteorological information, in combination with conservative engineering judgments of fuel particles, ETS design, required operational parameters such as run times and reactor power levels, the resulting analyses show that all potential radiological impacts are well within applicable standards.

(U) A review of historical meteorological data gathered from a sampling station positioned in reasonably close proximity to the proposed testing location indicated that a wind speed of 5.5 m/s (ft/s) and an atmospheric stability Class D were input variable to the MACCS code which reasonably represented actual conditions which can be expected to exist during operational testing.

(U) Initial computer analyses were performed using inversion layers of both 1,000 m (3,280ft) and 5,000 m (16,410 ft). The 1,000 m inversion layer results demonstrated that exceedance of applicable NESHAPs limits could occur in some severe operating scenarios. While the 5000 m inversion layer results showed compliance with NESHAPs, a review of published meteorological information indicated that the inversion layer was seldom at that height and could not be reasonably expected to accommodate operational testing. Iterations of variable inputs and data research determined that an inversion layer height of 2,000m (6,600 ft) resulted in NESHAPs compliance and existed with sufficient frequency that it would not impose unrealistic operational limitations.

(U) As the technology is improved, additional information may indicate that test conditions can be redefined to allow greater flexibility and continue to maintain radiological hazards within limits set by applicable standards.

(U) For routine operations, changes which may provide greater flexibility include:

- (U) reduced fuel particle release fractions based on better understanding of fuel and fuel element performance and release phenomenology,

- (U) ETS design or operation improvements to increase efficiency for effluent capture,

- (U) reducing run time or power levels to reduce radiological releases during operation, and

- (U) conducting tests under varied meteorological conditions.

(U) For potential accident impacts, a change to be considered would include:

- (U) reducing run time or power level to reduce the total inventory of radioactive fission products such that the total available for release would be maintained at a lower level, reducing the impact in the unlikely event of an accident.

[redacted]

(U) The testing program would define, compatible with testing objectives, the appropriate set of conditions under which tests would be conducted such that radiological releases would be within all applicable standards. To ensure that these established conditions can be achieved, the testing program would be subjected to the Safety Analysis Report (SAR) process. This process is a requirement of DOE Order 5481.1B - Safety Analysis and Review System. This order mandates the format to be used for writing the Safety Analysis Report. The order requires a two-stage process: 1) Preliminary Safety Analysis Report (PSAR) and 2) Final Safety Analysis Report (FSAR).

(U) Each reactor review would be conducted through the initiation of a review and approval process based on the Preliminary Safety Analysis Report (PSAR). The PSAR review and approval would provide reasonable assurance that all safety requirements and radiological release standards can be accomplished. An outline of the PIPET PSAR is provided as Appendix B.

(U) The Final Safety Analysis Report (FSAR) would be based on additional information to increase the confidence in the conclusions of the analysis. This information would include additional risk analyses and more detailed accident analyses based on more specific design data. This better design information combined with more knowledge regarding materials performance would result in a Design Basis Accident scenario. The FSAR process would conclusively demonstrate that potential impact levels would be within all safety requirements and radiological release standards. If this cannot be conclusively demonstrated in the FSAR, the testing program would not be conducted. If the FSAR identifies any consequence outside the EIS, additional NEPA review and analysis would be required before proceeding. The review and evaluation process required for the PSAR and FSAR is described in Section 3.2.1.1.5 and 3.2.2.1.5.

(U) It may be determined during the Safety Analysis process that the technology presently available and the conditions established for conducting the test program can be modified while maintaining potential impacts to the environment within limits set by applicable standards. Modifications which may be considered include:

a) (U) Meteorological Conditions: One of the most likely modifications to be considered if greater flexibility is required would be to conduct tests with different meteorological conditions than those identified in the program model conditions. The program could implement a real time dose prediction system, modeling dose using potential release quantities as well as current and predicted meteorological conditions. Flexibility to modify meteorological conditions would allow tests to be conducted, for instance, when the inversion layer is lower than required by program model conditions which would increase the times available to run tests.

b) (U) ETS Design: Control of the ETS to either improve the efficiency of the system or increase the decay time prior to release of the captured radionuclides is another consideration. It also may be possible to permanently capture and dispose of those radionuclides captured in the cryo-beds, eliminating this portion of the fission product release entirely. This increase in the removal efficiency of

the ETS also would provide greater flexibility to adjust other program conditions and still maintain potential impacts to the environment at insignificant levels.

c) (U) Test Run Times and Power Levels: Tests which have higher probability of radiological release, including the projected controlled tests to failure, could be performed when the core fission product inventory is low. Also, some of the tests would be run for shorter times and/or lower power levels than program model conditions. This would provide flexibility to modify other program conditions while maintaining insignificant impacts.

d) ([redacted]) Fuel Particles: The fission power or run time for testing could be increased if the estimates of potential radiological releases from the fuel particles could be reliably reduced. For example, if it could be demonstrated that the fuel would release only 10 percent of the expected fission product release used for program model conditions, it would be expected that the radiological effects of the entire test (all other factors remaining constant) would be reduced by an order of magnitude. Demonstrating that fuel particles would contain a larger portion of the nuclides during and after tests (i.e., reduce the release fraction) would allow more flexibility in adjusting other test conditions to maintain potential impacts to the environment at insignificant levels.

2.9 ENVIRONMENTAL CONSEQUENCES OF SITE-SPECIFIC ALTERNATIVES (U)

(U) The following section discusses the environmental consequences associated with the proposed action at each of the three site alternatives, SMTS, QUEST, and LOFT. This section is intended to give the reader an overview of the environmental effects associated with each alternative; a more complete understanding of these issues may be gained by reading Chapters 3 and 4.

(U) In addition to the uncertain nature of the developmental program discussed earlier, there also is some degree of uncertainty at the site specific level regarding use of the existing facilities at the LOFT site. There may be some advantages associated with the use of the containment facility in that it could result in lower radioactive releases if the emissions were contained within the vessel in the unlikely event of an accident. On the other hand, there is a potential disadvantage if the integrity of the structure is such that it would not withstand the pressures associated with an accident. In the unlikely event of such an accident, the facility could be damaged and unavailable for other testing programs in the future. Since there is insufficient information at this time to assess the probability of these types of uncertainties, they have not been addressed in this EIS. This uncertainty would be reduced as more information becomes available during the course of technology development and the detailed design safety analysis.

([redacted]) The issues compared here are only those in which the potential intensity of the environmental impact have been found to be low, moderate, or high as a result of the proposed action (See Appendix D for intensity criteria). In each case, mitigative measures would be applied to the impacts to reduce them to insignificant levels. It is therefore possible to have a high level of impact intensity that would result in insignificant environmental consequences because of the context of the impacts or as a result of the implementation of mitigation measures. For example, Table 2.9-1 indicates that noise would reach high levels of impact intensity and have potentially significant environmental consequences, but the consequences would be insignificant because of context and mitigation. Specifically, the general public would be far beyond the area of noise impacts and potential impacts to the few workers at the site during testing would be mitigated by their enclosure in a control bunker and the required use of protective safety equipment. Radiological consequences are also addressed due to the specific nature of the [redacted] program.

(U) In each case, mitigative measures would be applied to the potential impacts to reduce them to insignificant levels. Consideration of these impacts and mitigation in their full context has led to the determination that placement and testing of the [redacted] program at any of the three alternative sites would result in insignificant environmental consequences. Categories which have the potential for impacts above the negligible level are discussed here.

2.9.1 Land Use and Infrastructure (U)

(U) The amount of land required at all three sites is only a small percent of the total land of NTS and INEL, and the proposed action is compatible with existing operations of both installations. Land use impacts would be negligible at SMTS, but low at QUEST and LOFT. Vehicular traffic around QUEST and LOFT may be temporarily disrupted by testing

[redacted]

TABLE 2.9-1: SYNOPSIS OF SITE-SPECIFIC ENVIRONMENTAL IMPACTS (U)

Resource Area	Site	Intensity of Potential Impact				Mitigation Planned	Environmental Consequences
		Neg.	Low	Mod.	High		
Population & Economy	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Land Use & Infrastructure	SMTS	X				Where needed	Insignificant
	QUEST		X				
	LOFT		X				
Noise	SMTS				X	Yes	Potentially Significant[1]
	QUEST				X		
	LOFT				X		
Cultural Resources	SMTS		X			Where needed	Insignificant
	QUEST		X				
	LOFT	X					
Safety (non-nuclear)	SMTS			X		Yes	Potentially Significant[1]
	QUEST			X			
	LOFT			X			
Waste (LLW, TRU, MW, HW, SW)	SMTS	X				Where needed	Insignificant
	QUEST		X				
	LOFT		X				
Topography	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Geology	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Seismic Activity	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Water Resources	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Meteorology/ Air Quality	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Biological Resources	SMTS		X			Where needed	Insignificant
	QUEST		X				
	LOFT	X					
Radiological Normal Operations	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					
Radiological Accidents	SMTS	X				No	Insignificant
	QUEST	X					
	LOFT	X					

[1] (U) Potential significant environmental consequence would be mitigated to insignificant levels as discussed in Chapter 4.

[redacted]

activities. In the context of the total traffic volume, the traffic disrupted would be temporary, infrequent and of short duration, and alternative routes would be available. Some grazing would be disrupted at INEL, but in the context of total grazing land available on the installation, the impact would be low. The impacts would be low and environmental consequences would be insignificant.

2.9.2 Noise (U)

(U) Noise impacts from construction and operations would be high at all three sites from the use of heavy equipment during construction and from operation of the ETS during operation. Modification of the LOFT facility would require less construction than SMTS or QUEST, resulting in slightly lower impacts. Potential noise impacts would be high and environmental consequences would be potentially significant. However, since the general public would be far beyond the area of noise impacts and potential impacts to the few workers exposed during testing would be mitigated by their enclosure in a bunker and the use of protective safety equipment the environmental consequences would be insignificant.

2.9.3 Cultural Resources (U)

(U) Surveys for cultural resources have been conducted and the Nevada State Historic Preservation Office (SHPO) has been consulted regarding the SMTS site, the water supply well site, and the power line to the site. This has not, however, been accomplished for the power line nor the waterline to the water supply well. Cultural resource surveys would, therefore, be conducted before construction of these lines commenced and the Nevada SHPO would be consulted. Mitigation measures would be implemented to modify or reroute the lines (or any resources discovered would be recovered) if required by the SHPO following consultation to reduce the environmental consequences to insignificant levels as required by the SHPO. Consultation and surveys have not been conducted for QUEST. The LOFT area has been previously disturbed by the construction of existing facilities. If SHPO consultation indicates that there are potential impacts to cultural resources at either INEL site, surveys would also be conducted and mitigation measures implemented if required by the SHPO following consultation.

2.9.4 Safety (U)

(U) Potential safety impacts would be moderate and environmental consequences would be potentially significant at all three alternative sites. However, in addition to normal construction and operational safety concerns, any site chosen would require strict enforcement of mitigative measures to reduce the impacts from accidents during the storage and handling of hydrogen, oxygen, or helium. Because of extensive training and precautionary preparations and the safety design features of the facility, there is a low probability of an accident, and the environmental consequences, therefore, would be insignificant.

2.9.5 Waste (U)

([redacted]) Waste impacts would be low at QUEST and LOFT, and negligible at SMTS. It is projected that all low-level radiological waste would be processed and stored at the installation where

testing would occur. Impacts from RCRA-regulated hazardous waste and any mixed and TRU wastes generated by [redacted] program activities would be handled within existing process streams. The handling of all types of waste, radiological and non-radiological, would not require exceptional procedures. Since the wastes generated by the [redacted] program would be managed in accordance with existing waste management procedures which include protection of the environment, impacts would be negligible to low and the environmental consequences would be insignificant at the three alternative sites.

2.9.6 Biological Resources (U)

([redacted]) Biological resource surveys have not been conducted for some of the areas to be disturbed at SMTS and QUEST, but the low-diversity habitat of the areas indicate that potential biological resource impacts would be low at these two sites. Since the LOFT area has been previously disturbed for the construction of existing facilities, no further impacts are expected. The potential impacts are, therefore, considered negligible at LOFT. The [redacted] program has committed to conducting biological resource surveys for areas not previously surveyed and, if any threatened or endangered species are identified, FWS consultation would take place. Any potential impacts would be mitigated to insignificant levels.

2.9.7 Radiological Impacts (U)

(U) A site specific comparison of radiological impacts to human health from normal operations as well as a bounding case accident scenario is included here. The health impacts are predicted using the MACCS model under program model conditions.

(U) A synopsis of health effects is presented as Table 2.9-2. The figures in the upper portion of the table describe the increased risk (above the already existing risk) to the maximally exposed individual [within range of the testing activities (80 km or 50 mi)] of dying of cancer as well as the increased risk of producing offspring with genetic defects due to the ground testing activities. For example, the maximally exposed individual at either SMTS, QUEST, or LOFT would face an increased risk (above the already existing risk of 2.2×10^{-1}) of dying of cancer of 7×10^{-4} from normal operations and 1×10^{-4} from a GTA bounding case accident. This same individual would face an increased risk (above the already existing risk of 2.5×10^{-2} at NTS and 2.0×10^{-2} at INEL) of producing offspring with genetic disorders of 2×10^{-6} from normal operations and 3×10^{-5} from a GTA accident. Again, these risks are above and beyond the already existing risk of dying of cancer and producing offspring with genetic defects.

(U) The figures in the lower part of Table 2.9-2 show the additional cancer fatalities and additional genetic disorders expected in the population within range of testing activities (80 km) due to testing at each site. For example, testing at SMTS is expected to cause 2×10^{-4} (much less than one) additional cancer fatalities to the entire population. That is to say, since 22 percent of the affected population of 5,400 (1,188 individuals) are ordinarily expected to die from cancer (Craggier, 1991), the performance of ground testing activities would add only 2×10^{-4} cancer fatalities to this for an expected cancer fatality total of 1,188.0002. This same population would ordinarily expect to produce 2.2 percent of its offspring (or 119 individuals) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 6

TABLE 2.9-2:
HEALTH IMPACTS (U)

		INCREASED RISK OF HEALTH IMPACTS TO MAXIMALLY EXPOSED INDIVIDUAL FOR WHOLE PROJECT[a,b]		
		SMTS	QUEST	LOFT
Normal Operations	Increased Cancer Risk	7×10^{4}	7×10^{4}	7×10^{4}
	Increased Genetic Disorder Risk	2×10^{4}	2×10^{4}	2×10^{4}
GA Bounding Case Accident	Increased Cancer Risk	1×10^{4}	1×10^{-4}	1×10^{4}
	Increased Genetic Disorder Risk	3×10^{5}	3×10^{5}	3×10^{5}

		INCREASE IN NUMBER OF HEALTH IMPACTS TO 80 KM POPULATION FOR WHOLE PROJECT[c]		
		SMTS	QUEST	LOFT
Normal Operations	Additional Cancer Fatalities	2×10^{4}	4-5 x 10^{4}[d]	4-5 x 10^{3}
	Additional Genetic Disorders	6-8 x 10^{5}	1-2 x 10^{4}	1-2 x 10^{4}
GA Bounding Case Accident	Additional Cancer Fatalities	5-9 x 10^{4}	3-5 x 10^{3}	3-5 x 10^{3}
	Additional Genetic Disorders	2-3 x 10^{4}	9-20 x 10^{4}	9-20 x 10^{4}

[a] (U) The values presented are the additional risk, to the maximally exposed individual, of cancer fatality or genetic disorder in the next generation, above the existing without project risk. The existing risk of cancer fatalities at both NTS and INEL is 2.2 x [illegible] while the existing risk of genetic defects in subsequent generations is 2.3 x [illegible] at NTS and [illegible] at INEL.

[b] (U) Whole project combines the operations of the PIPET, Mini-GA, GTA and QTA test programs.

[c] (U) The values presented are the additional number of cancer fatalities in the existing population and the additional number of genetic disorders expected in the next generation above the existing without project conditions. These values are not risks, probabilities, nor percentages. (Without the project, the expected number of cancer fatalities and offspring genetic disorders in the 80 km population around SMTS are 1,185 and 119 respectively, and the expected number of cancer fatalities and offspring genetic disorders in the 80 km population around INEL are 20,840 and 2,530 respectively.)

[d] (U) Indicates range of 4 x [illegible] to 5 x [illegible].

x 10^{-5} to 8 x 10^{-5} additional genetic disorder cases to the offspring of the entire population from normal operations. A GTA bounding case accident would cause an additional 5 x 10^{-4} to 9 x 10^{-4} cancer fatalities to the entire population as well as 2 x 10^{-4} to 3 x 10^{-4} additional offspring genetic disorders.

(U) The figures in Table 2.9-2 for QUEST and LOFT may be similarly interpreted. For example, testing at either the QUEST or LOFT site is expected to cause 4 x 10^{-3} to 5 x 10^{-3} (much less than one) additional cancer fatalities to the entire population. That is to say, since 22 percent of the affected population of 127,494 (28,049 individuals) are ordinarily expected to die from cancer (Krieger, 1991), the performance of ground testing activities would add only 4 x 10^{-3} to 5 x 10^{-3} cancer fatalities to this for an expected cancer fatality total of 28,049.0045. This same population would ordinarily expect to produce 2.0 percent of its offspring (or 2,550 individuals) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 1 x 10^{-3} to 2 x 10^{-3} additional genetic disorder cases to the entire population from normal operations. A GTA bounding case accident would cause an additional 3 x 10^{-2} to 5 x 10^{-2} cancer fatalities to the entire population as well as 9 x 10^{-3} to 2 x 10^{-2} additional offspring genetic disorders.

Normal Operations (U)

(U) The impacts described below result from radiological doses which do not exceed applicable standards and result in insignificant environmental consequences. Included here are alterations in the program model conditions which may be varied (when balanced by an offsetting change) while maintaining the radiological doses to the maximally exposed individual and the downwind population within applicable standards. These alterations in program model conditions are improved fuel performance, variations in testing times and power levels, improvements in ETS performance, and changes in meteorological conditions. These were discussed in Section 2.8.7.

(U) Maximally Exposed Individual: Radiological doses to the maximally exposed individual from program model conditions during normal operations at the three alternative sites do not exceed NESHAP standards. Potential health impacts at each site, shown in Table 2.9-2, demonstrate insignificant environmental consequences of the proposed action. Even at the EPA NESHAP limit of 10 mrem per year for the four year test period, expected health effects to the maximally exposed individual would be an increased risk of 3 x 10^{-5} latent cancer fatalities and 1 x 10^{-5} genetic defects to succeeding generations.

([redacted]) Total Population: Radiological doses to the downwind population of a [redacted] testing station do not exceed individual exposure standards at any of the three sites under the program model conditions. Population dose would be controlled by limiting program operations to times of favorable wind speed and direction. The dose received from SMTS operations would be slightly lower than that from QUEST or LOFT. This is due to the greater population in the INEL area versus the NTS area and the additional distance to the fence at the NTS site. Potential population health effects, shown in Table 2.9-2, indicate that potential health impacts are sufficiently low that health effects are not expected and the impact would be negligible. Therefore, environmental consequences would be insignificant.

[redacted]

Bounding Case Accident Scenario (U)

(U) The following is a site-specific comparison of the radiological impacts to human health from the hypothetical bounding case accident scenario. The health impacts are calculated using the MACCS model. The impacts described would result from radiological doses of program model conditions which do not exceed ANSI/ANS 15.7 standards. This bounding case accident scenario could only occur during testing periods.

(U) Maximally Exposed Individual: Radiological doses to the maximally exposed individual from an accident scenario at the three alternative sites are well below applicable standards in each case. In the unlikely event of an accident, doses and health impacts to the maximally exposed individual would be minimal and within applicable standards. Even at the ANSI/ANS 15.7 limit on exposure of 500 mrem, the increased risk of health effects to the maximally exposed individual would be 4 x 10^{-4} latent cancer fatalities and 1 x 10^{-4} genetic defects to succeeding generations. Thus, the potential health impacts would be negligible and the environmental consequences of these impacts would be insignificant.

(U) Downwind Population: Radiological doses to the population downwind of a testing station would not exceed individual exposure standards at all three sites under program model conditions. The health impacts to the population around the SMTS would be slightly less than to the population around QUEST and LOFT due to the lower total population in the SMTS vicinity and are shown in Table 2.9-2. These impacts are considered negligible. In this context, the environmental consequences would be insignificant.

Synopsis (U)

(U) Because the predicted radiological effects of ground testing and transporting of radiological materials as well as the radiological effects of the bounding case accident are sufficiently low that increased health effects are not expected, the impact of radiological emissions on the environment would be negligible. Therefore, the environmental consequences would be insignificant.

[redacted]

3.0 AFFECTED ENVIRONMENT (U)

(U) This section provides an overview of the environment that would be affected by the proposed action. Environmental descriptions in this section are grouped by facilities and locations involved in (1) materials and component development and testing and (2) system ground testing. More detailed descriptions have been provided for the system ground test site alternatives based on the potentially significant environmental impacts that would result from test activities. The descriptions of this section form the baseline from which potential impacts, described in Section 4, can be estimated and analyzed.

3.1 MATERIALS AND COMPONENT DEVELOPMENT AND TESTING FACILITIES (U)

([redacted]) Facilities involved in materials and component development and testing include Brookhaven National Laboratory (BNL); Babcock and Wilcox (B&W) Naval Nuclear Fuel Division (NNFD); Sandia National Laboratories (SNL); Aerojet Propulsion Division; Hercules Aerospace Corporation; Allied-Signal Aerospace/Garrett Fluid Systems Division; and Grumman Space Electronics Division (Figure 3.1-1).

(U) This section describes the environmental setting of each facility in terms of physical and operational characteristics, permit status, and previous environmental documentation. Specific physical characteristics include installation size, support and test facilities, and environmental and public health and safety conditions. Operational characteristics include the socioeconomic conditions, the characteristics of the surrounding communities, and the infrastructure characteristics of solid waste, sewage treatment, transportation, and water supply. Referenced permits are those that relate to air quality, water quality, and hazardous waste. Facilities that are involved in the manufacture and testing of nuclear materials have more detailed descriptions of relevant safety procedures.

3.1.1 Brookhaven National Laboratory (U)

(U) Brookhaven National Laboratory (BNL) (Figure 3.1-2) is a multiprogram laboratory operated by Associated Universities, Inc. for the Department of Energy. The responsibilities of BNL include research in high-energy physics, nuclear physics, life sciences, nuclear medicine, materials sciences, and chemical sciences. Management of the laboratory operations is assigned to the Brookhaven Area Office under the DOE Chicago Operations Office. BNL occupies a level wooded site of about 1,400 hectares (3,500 acres), with a developed area of about 670 hectares (1,680 acres). Its location, about 100 kilometers (60 mi) east of New York City, places BNL at the approximate center of Long Island. Suffolk County has a total population of 1,300,000.

(U) BNL has a full-time staff of 3300 to 4000 employees. In addition, about 1500 off-site personnel participate in research on shorter-term projects as collaborators, consultants, or students. Operations are currently housed in 354 buildings with a total floor space of about 400,000 square meters (3.7 million ft^2) including trailers and modular buildings (DOE, 1990). The infrastructure at BNL is sufficiently developed to support all major program activities.

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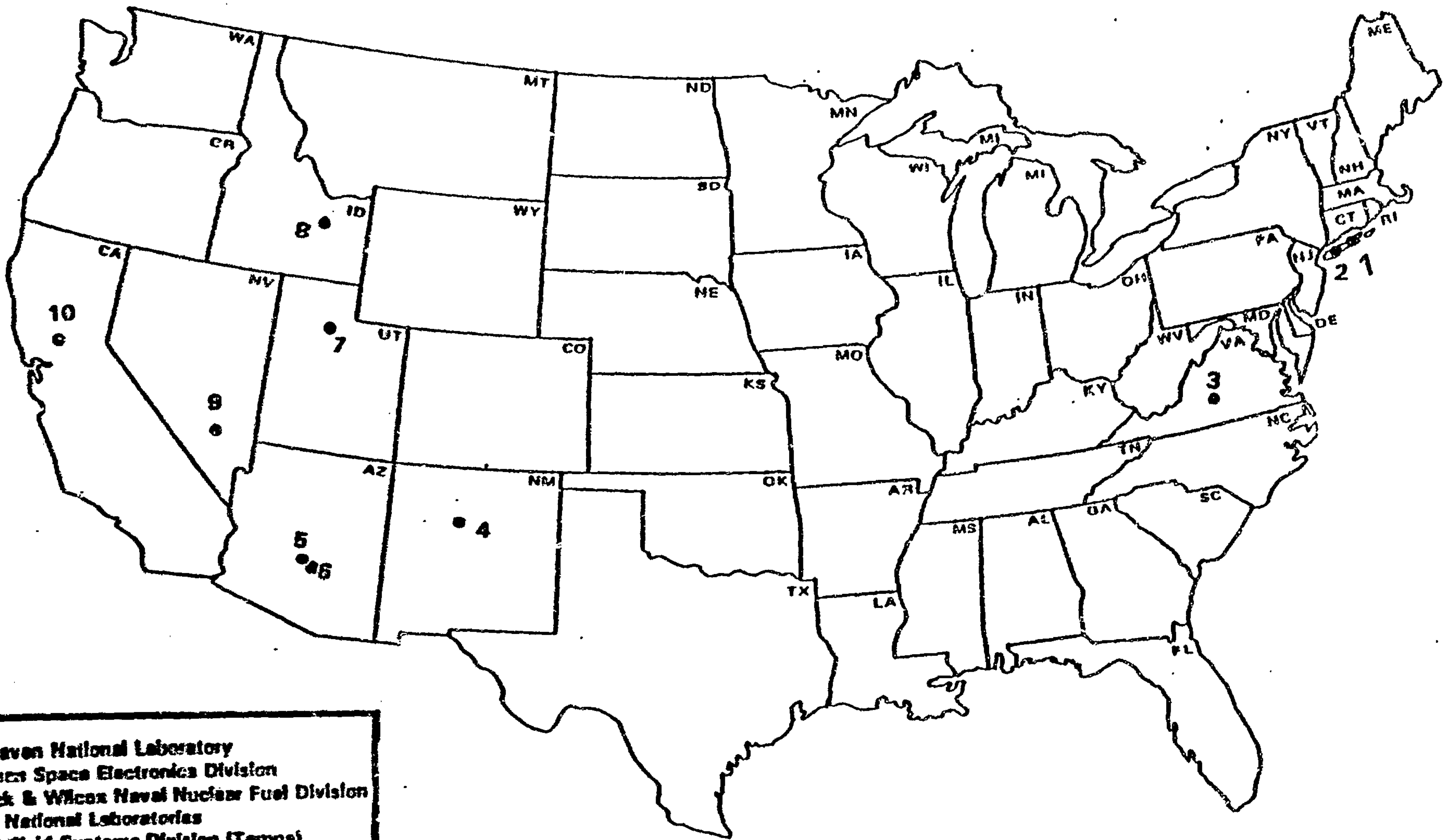

1 Brookhaven National Laboratory
2 Grumman Space Electronics Division
3 Babcock & Wilcox Naval Nuclear Fuel Division
4 Sandia National Laboratories
5 Garrett Fluid Systems Division (Tempe)
6 Garrett Fluid Systems Division (San Tan)
7 Hercules, Inc.
8 Idaho National Engineering Laboratory
9 Nevada Test Site
10 Aerojet Propulsion Division

[redacted]

Figure 3.1-1 [redacted]

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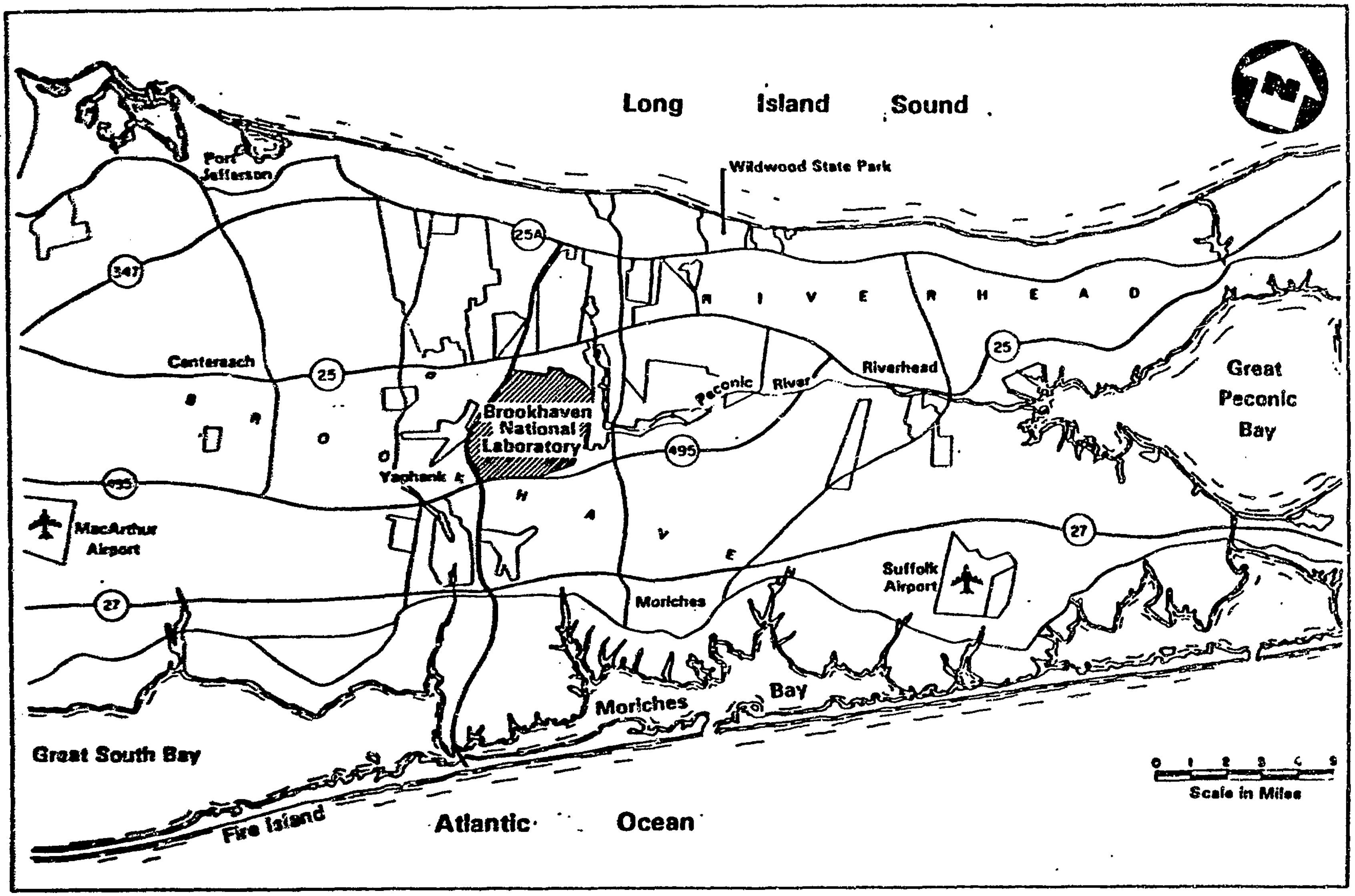

Source: BNL, 1989

Figure 3.1-2 [redacted]Brookhaven National Laboratory [redacted]

[redacted]

(U) Implementation guidance for the laboratory safety program is set forth in the Occupational Health and Safety Guides which make up the Laboratory Safety Manual. The Occupational Health and Safety Guides establish the requirements for a safe working environment and define responsibility for implementation. Development of these guides is coordinated by the Safety and Environmental Protection (SEP) Division. They are reviewed by the operating departments and the appropriate Laboratory safety committee, and approved for release by the Assistant Director for Safety. Any deviations from the requirements set forth in these guides must be approved by the Assistant Director for Safety.

(U) Hearing protection is required for BNL workers in work locations and activities where hearing hazards or potential hazards exist as discussed in Section 1.16.0 of the BNL Safety Manual. Health and safety issues that have been identified at the facility are currently being addressed through implementation of the Facility Action Plan (DOE, 1990c).

(U) For new construction, modifications to existing facilities, and new projects with significant potential safety hazards a safety assessment is required. Safety assessments must be completed in a timely manner to assure early identification of potential hazards so that adequate funds for safety-related items or systems can be included in the project proposal. If warranted by identified hazards the Assistant Director for Safety, upon advice from the Safety and Environmental Protection Division, shall require a formal Safety Analysis Report (SAR) to be completed by the responsible Department prior to operation. The Assistant Director for Safety shall request one of the standing safety committees to review the SAR and make appropriate recommendations. Operation of the facility shall be authorized by the Assistant Director for Safety upon completion of the review and resolution of all recommendations as well as completion of an occupancy readiness review.

(U) There is a documented Material Control Plan for the Special Nuclear Material (SNM) to be used for materials compatibility testing (BNL, 1990). The plan ensures compliance with DOE Order 5633.3 as well as BNL's Safety Manual. The BNL Safety Manual has established waste management procedures and policies for both radioactive and chemically hazardous waste (i.e. solvents) generated as a result of program activities. These procedures ensure that wastes are identified, segregated, packaged, handled, stored, transported, and disposed of in accordance with applicable regulations (BNL, 1990).

(U) BNL is underlain by thick deposits of sand and gravel that are part of a sole-source aquifer that provides the water supply for most of Long Island. The aquifer is protected by local land use zoning regulations. Vegetation at the BNL site is predominantly scrub oak and pine. As surrounding areas have been cleared for development, the BNL has been increasingly important as a refuge for wildlife. BNL shelters about 30 species of mammals, including an increasing herd of white-tailed deer (DOE, 1990c). No known threatened or endangered species are believed to inhabit the facility. No known cultural resources are known to exist at the facility (BNL, 1991).

[redacted]

3.1.2 Babcock and Wilcox (U)

(U) The Babcock & Wilcox (B&W) Company is an operating unit of McDermott, Inc. Two divisions of the Defense and Nuclear Power group of B&W are located at the Mt. Athos site: the Naval Nuclear Fuel Division (NNFD) and the Lynchburg Technology Center (LTC) (formally the NNFD-Research Laboratory). The Mt. Athos site is situated on a 210 hectare (525 acre) area bordering the James River 16 km (10 mi) east of Lynchburg in Campbell County, Virginia (Figure 3.1-3). Approximately 2500 people are employed by Babcock & Wilcox at the Mt. Athos site. The land in the immediate vicinity of the plant is sparsely inhabited. The site is isolated from sensitive noise receptors. No significant noise issues have been identified.

(U) The NNFD is a United States Nuclear Regulatory Commission (USNRC) licensed facility pursuant to 10 CFR 30, 40, and 70, and as such, is authorized to conduct activities for the fabrication of fuel components containing NRC licensed material. The Lynchburg Technology Center (LTC) is an NRC licensee authorized to conduct broad research utilizing NRC licensed material. Work at NNFD is performed under the terms and conditions of Special Nuclear Materials License, SNM-42. Work at the LTC is performed under the terms and conditions of Special Nuclear Materials License - 778. NNFD's SNM-42 license issued by the USNRC was first approved on June 30, 1965. Since that time, it has been renewed twice. The latest renewal application was submitted July 31, 1989 and is undergoing NRC review. Currently, NNFD is operating under the timely renewal provision of 10 CFR 70.33 (b). In support of the renewal application is an Environmental Report submitted to the NRC in October, 1990. The SNM-778 License was first issued by the NRC on September 16, 1966. Since then, the license has been renewed three times, the latest renewal date being July 31, 1987. SNM-778 is also supported by an Environmental Report dated October, 1985. The NRC licensing process, which includes review and approval of Environmental Reports, describes the manner by which NRC licenses meet NEPA requirements.

(U) NNFD conducts activities according to policies and procedures issued by McDermott, Inc. Pursuant to these corporate policies and procedures, NNFD maintains internal manuals located in operating areas which communicate specific safety information. These manuals include the Industrial Health and Safety Manual, the Nuclear Criticality Safety Manual, and the Radiation Protection Manual. Work-groups such as environmental, safety, security, and materials control and accountability have internal procedures which govern their activities. A review/approval plan control system ensures that personnel have available to them the proper procedures.

(U) New equipment and/or changes to plant processes such as tests, processing of fuel particles or fabrication of fuel elements are administered through a License Evaluation Request (LER) program. The LER program brings proposed changes before the Nuclear Licensing Board (NLB) for evaluation and approval. Evaluations of individual LER's are performed by safety and safeguards professionals covering environmental protection; industrial health and safety; licensing; nuclear criticality safety; nuclear materials control (accountability); radiation protection; and security.

[redacted]

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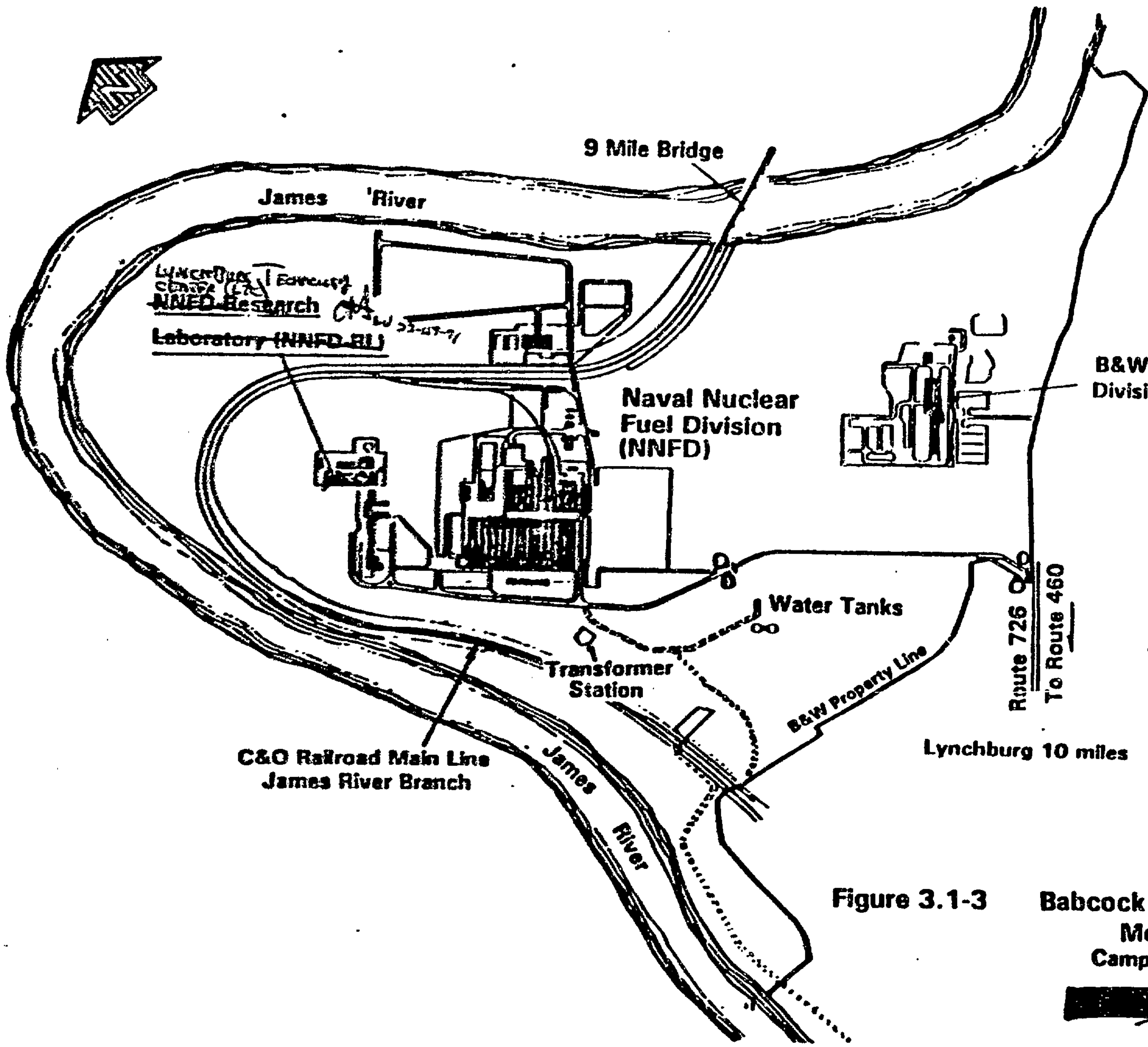

Total Acres 525

Fenced Areas (NNFD) 39

All Operations Including Support Areas
437,450 square feet (NNFD)

Figure 3.1-3 Babcock & Wilcox Property
Mount Athos
Campbell County VA

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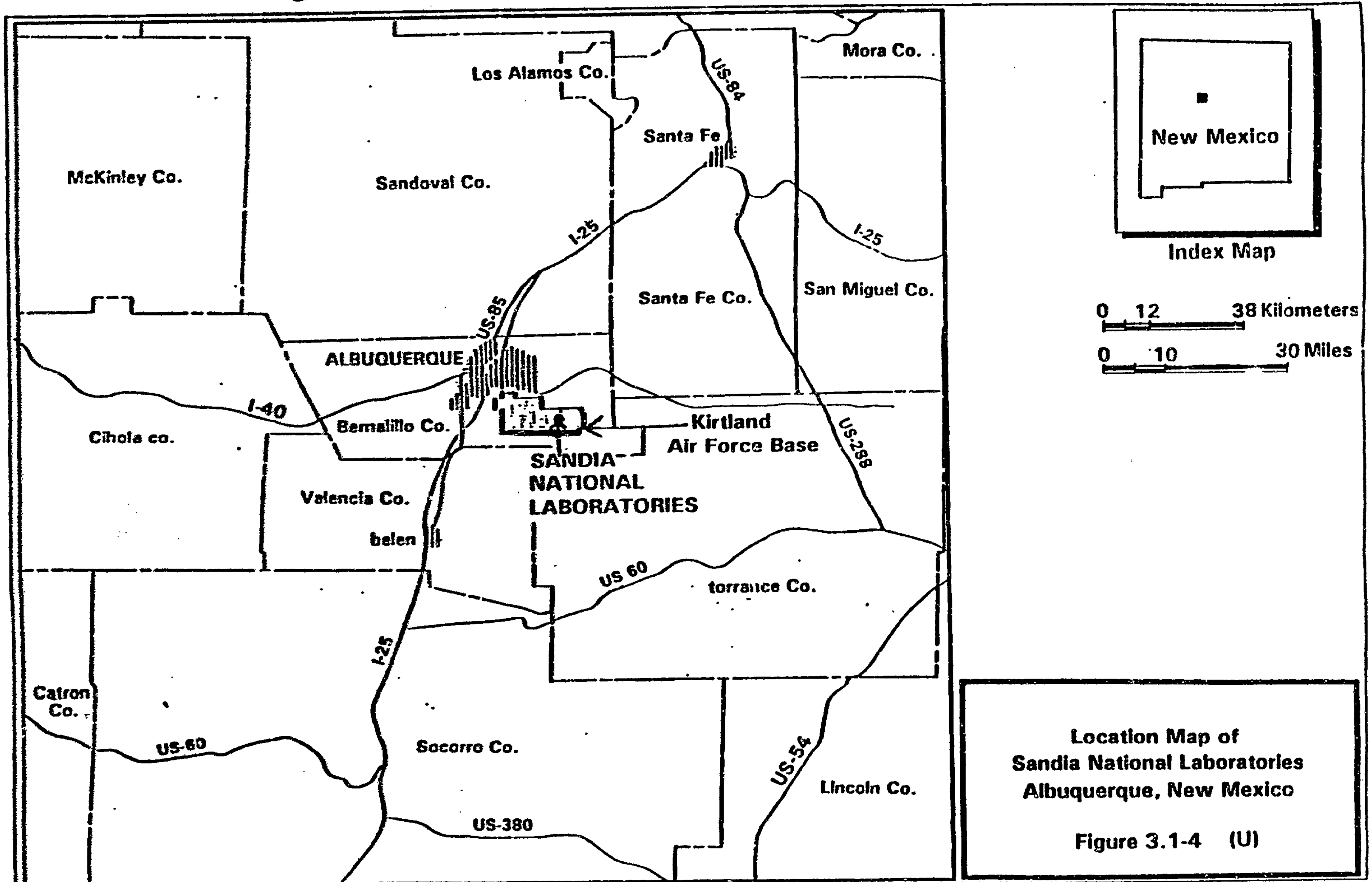

Location Map of
Sandia National Laboratories
Albuquerque, New Mexico

Figure 3.1-4 (U)

Source: Strategic Target System (STARS) Final EA July 1990

[redacted]

technical areas where research and development of weapons systems, limited assembly of weapons system components, and other related activities are conducted. SNL research facilities include the Annular Core Research Reactor (ACRR) and the Sandia Pulsed Reactor (SPR) Facility. There are approximately 7,300 civilian employees at the SNL facility.

(U) No noise issues have been identified at SNL. Public health and safety risks include radiological release, fire, explosion, release of toxic materials, aircraft crashes, electrical failures, and high-power microwave emissions. Sandia National Laboratories operates in accordance with the Sandia Laboratories Environmental Safety and Health Management Assurance Notebook.

(U) Operation of the ACRR and SPR facilities currently comply with all DOE orders that specify reactor safety standards, safety analysis report requirements, siting, licensing, and operating procedures and DOE review and approval procedures (Table 3.1-1). Compliance with these orders ensure that exposures resulting from severe accidents do not exceed applicable standards.

(U) Safety Analysis Reports for the ACRR and SPR facilities (SNL, 1978 and SNL, 1981) define upper limit (bounding) operating and accident scenarios. There are analyses of the impacts of these bounding limits both on-site and at the site boundary. Impacts are described in terms of radiation dose commitments and are compared to applicable regulatory limits. The SARs serve as the operating and safety bases against which future activities are compared.

(U) The Sandia Internal Review Appraisal System (SIRAS) ensures that proper safety analyses are performed for each new experiment and that the proposed experiments are properly planned, documented, reviewed, and approved. Proposed experiments are described and analyzed by staff members, according to established requirements. An Experiment Plan is prepared and sufficiently reviewed by Safety Committees prior to implementation. The review includes assessment of safety issues as presented, and a conclusion as to whether the proposed experiment falls within the reactor safety envelope and the approved technical specifications. Issues which pertain to radiation safety or criticality safety are reviewed by a Radiation Criticality Safety Committee (RCSC). External reviews are performed as required, primarily to determine that the Experiment Plan has properly considered all regulatory requirements.

(U) If it is concluded that a proposed experiment is within the technical specifications described in the SAR, line management can approve the experiment, experimental procedures, operating procedures and safety procedures. If the proposed experiment requires new technical specifications, or is outside the approved operating conditions, then approval of the experiment and new Tech Specs by DOE-Albuquerque (DOE-AL) is required. DOE-AL also periodically reviews internally approved experiments during program appraisals.

(U) Solid waste is disposed of at the Kirtland AFB sanitary landfill. Portions of the SNL sewage treatment demand are handled by the Kirtland AFB and City of Albuquerque systems. The remaining sewage is treated by an on-base septic system. SNL's principal source of water is ground water from the Santa Fe group aquifers. Daily demand is equivalent to 4 million liters (1 million gal) and the daily delivery capacity is equivalent to 12 million liters (3 million gal).

[redacted]

TABLE 3.1-1
DOE NUCLEAR SAFETY ORDERS (U)

NUMBER	DESCRIPTION
DOE 5400.5	Radiation protection of the public and the environment
DOE 5480.5	Safety of nuclear facilities
DOE 5480.6	Safety of DOE-owned nuclear reactors
DOE 5480.11	Radiation protection for occupational workers
DOE 5481.1B	Safety analysis and review system
DOE 5500.3	Facility emergency planning preparedness and response programs
DOE 5700.6B	Quality assurance

[redacted]

Liquid sanitary waste is discharged into the Kirtland AFB sewage system. Electrical power is supplied by the Public Service Company of New Mexico through the 115kV Eubank Switching Station and several substations.

(U) SNL complies with federal standards for water quality, hazardous materials, and air quality. SNL is located in a nonattainment area for carbon monoxide. Ground water monitoring gives no indication of ground water pollution.

(U) Threatened and Endangered species that have been known to occur in the vicinity of SNL include the bald eagle (Haliaeetus leucocephalus), peregrine falcon (Falco peregrinus anatum), and whooping crane (Grus americana). Listed category 2 species include the Mexican spotted owl (Strix occidentalis lucida) and Grama grass cactus (Toumeya papyracanthus) (USAF, 1991). Ground surveys conducted at SNL have not encountered threatened or endangered species but the birds may pass through the area while migrating (Army, 1990b). No cultural resources have been identified at SNL.

3.1.4 Aerojet Propulsion Division (U)

(U) The Aerojet Propulsion Division is a commercial/industrial facility in Sacramento County, CA (Figure 3.1-5). The surrounding communities in Sacramento County have a combined population of approximately 993,000. Approximately 3,500 people are employed at the installation (Army, 1990c). The nearest population center is the city of Folsom, CA located 5 kilometers (3 mi) northeast of the facility.

(U) Aerojet has all applicable federal, state, and local permits and authorizations necessary for operations. The facility complies with federal standards for water quality and air quality, although it is located within a nonattainment area for ozone and carbon monoxide. This facility was placed on the Environmental Protection Agency's (EPA) National Priorities List in 1979 for release of trichloroethylene (TCE) into several municipal wells. Aerojet has since installed six water treatment facilities that capture these contaminants. The EPA is currently conducting a feasibility study on remediation. No additional health and safety issues have been identified at the facility (Army, 1990c).

(U) There are no recorded historic or archaeological sites at the facility, and no threatened or endangered species are known to frequent the facility. All hazardous materials used are disposed of according to the specific RCRA permit requirements and the Aerojet Safety Procedures Manual. Facility infrastructure is supported by adjacent communities and demand is within capacity (Army, 1990c).

3.1.5 Hercules Aerospace Corporation (U)

(U) Hercules Aerospace Corporation is a commercial/industrial facility in Magna, UT, approximately 25 km (15 mi) from Salt Lake City, Utah (Figure 3.1-6). The surrounding communities in Salt Lake County have a combined population of approximately 705,000 people.

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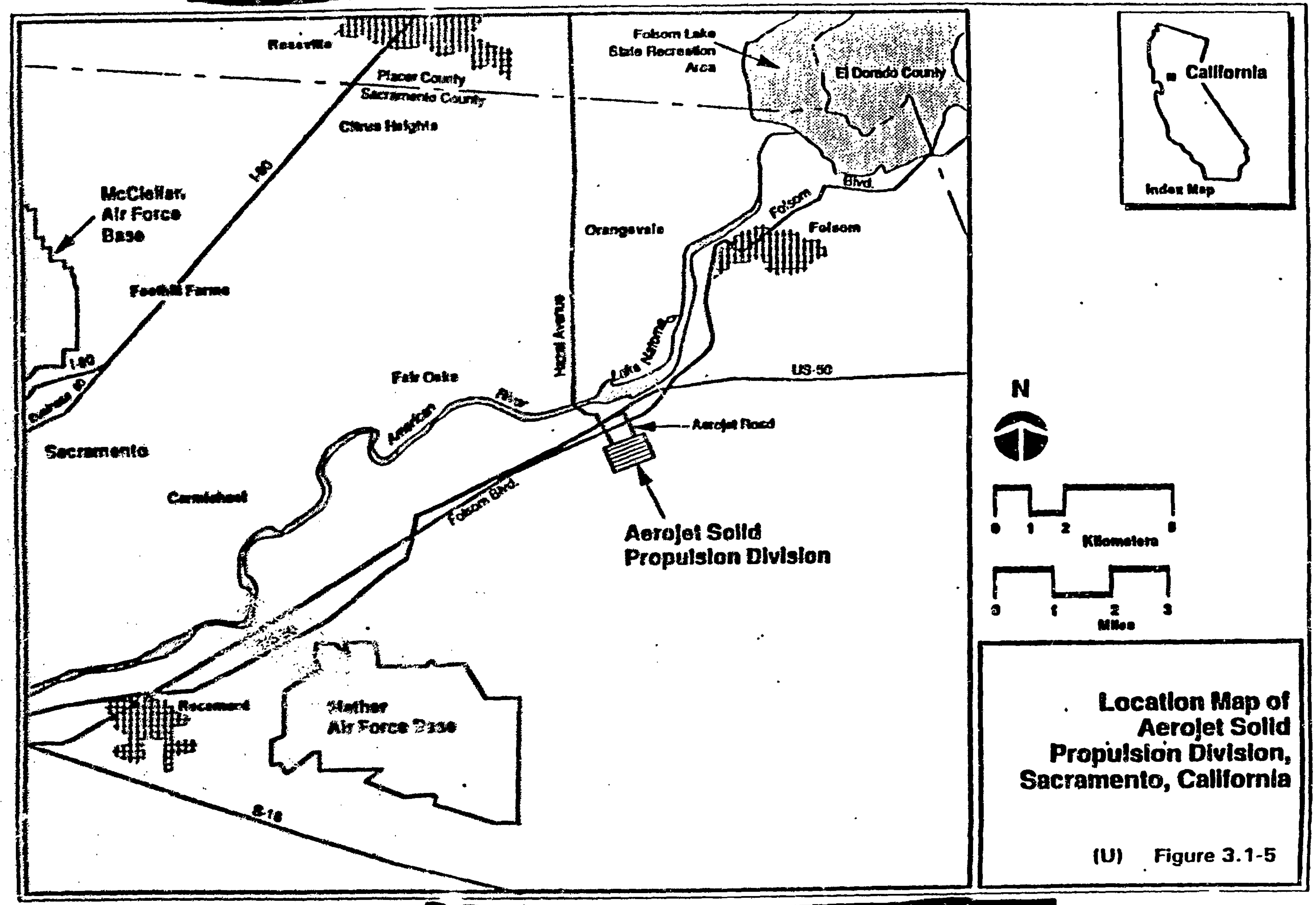

Location Map of Aerojet Solid Propulsion Division, Sacramento, California

(U) Figure 3.1-5

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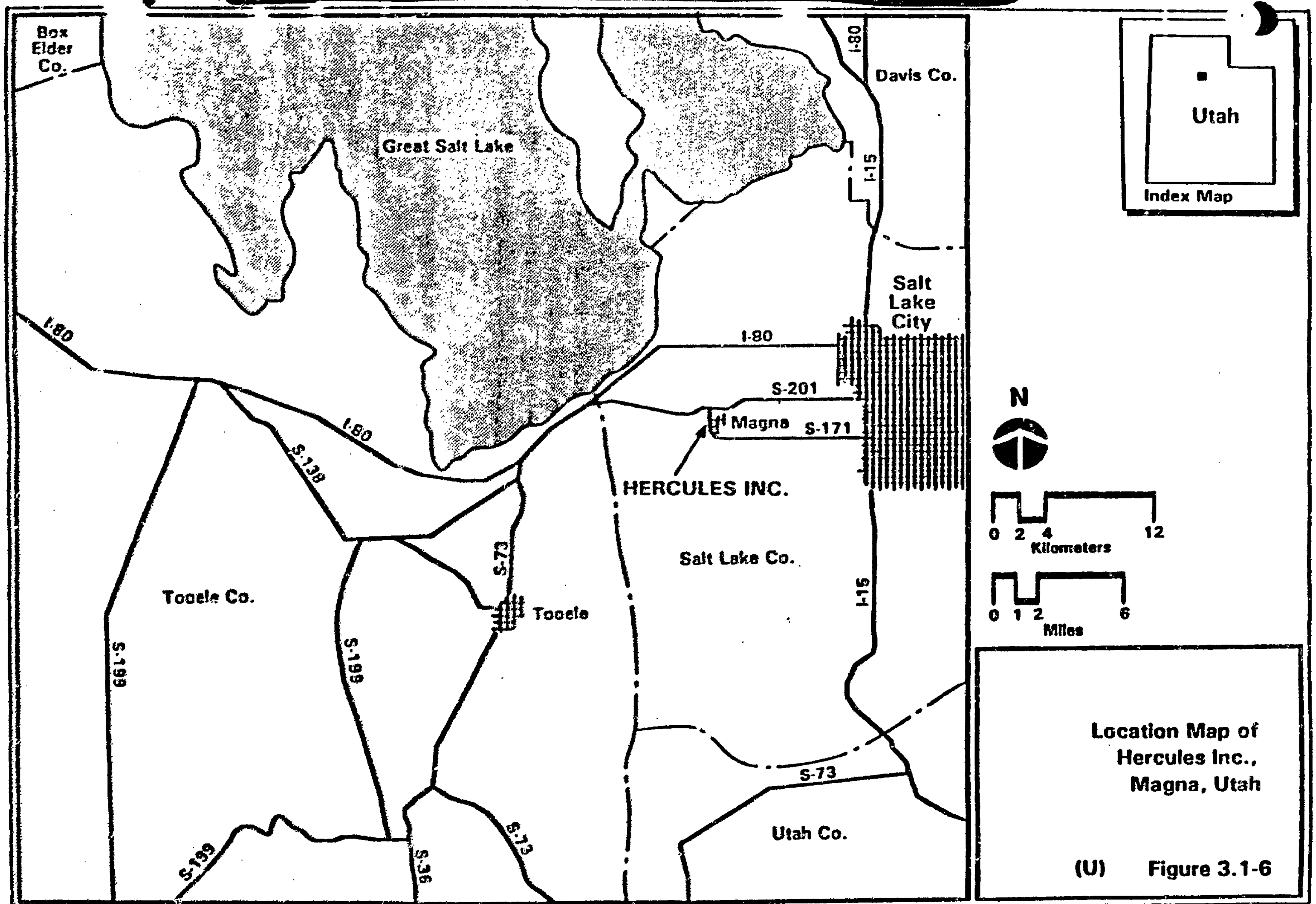

Location Map of Hercules Inc., Magna, Utah

(U) Figure 3.1-6

[redacted]

Approximately 4,000 people are employed at the installation. Hercules performs rocket motor case manufacturing, propellant mixing/casting operations and manufacturing of carbon fiber, composite structures, impregnated materials, and carbon-carbon structures.

(U) Hercules Aerospace Corporation has all applicable federal, state, and local permits and authorizations necessary for operation (Army, 1990c). The facility complies with Federal standards for water quality and air quality although it is located within a nonattainment area for ozone, carbon monoxide, sulfur dioxide and particulates. Hercules has an extensive and ongoing industrial hygiene program. Potential health and safety concerns include chemical and respiratory exposure and noise hazards. Hercules is currently in compliance with all applicable OSHA regulations in these areas (Army, 1990c). All hazardous materials are disposed of according to the specific RCRA permit requirements.

(U) There are no recorded historic or archaeological sites at the facility, and no threatened or endangered species are known to frequent the area.

3.1.6 Allied Aerospace Garrett Fluid Systems Division (GFSD) (U)

(U) Garrett Fluid Systems Division (GFSD) will carry out component manufacturing activities at its Tempe facility and component testing at its San Tan facility (Figure 3.1-7). Turbopump testing in support of the [redacted] Program would be conducted by the ALAD facility, located in Torrance, CA.

<u>Activities at the GFSD Tempe facility</u> (U)

(U) At the Tempe facility, GFSD has been engaged in the manufacture and assembly of aerospace fluid systems and components for a variety of commercial, industrial, and military applications since 1981. Manufacturing operations at the facility include pneumatic systems, undersea propulsion, space power, hydraulic systems, and fuel systems. Base metals used in the manufacturing processes include stainless steel, carbon steel, nickel-steel alloy, aluminum, magnesium, and titanium. Currently there are approximately 3,200 employees at the Tempe facility.

(U) The facility occupies 58 hectares (145 acres) in a relatively flat formerly agricultural area. It is surrounded by agricultural land on the south, north, and west sides and a recreational facility and agricultural land on the east side. Much of the existing facility, located on the southwestern portion of the property is paved or provided with curbing that separates landscaped areas from the pavement. A major portion of the property located north and east of existing facilities is undeveloped.

(U) The facility has written procedures for environmental operations, and has a documented personnel training program. No health and safety issues have been identified and no noise issues have been identified at the facility. The facility is in full compliance with all applicable environmental regulations, and has current air and public-owned treatment works discharge permits as well as an EPA ID number. Wastes are disposed of at licensed and approved

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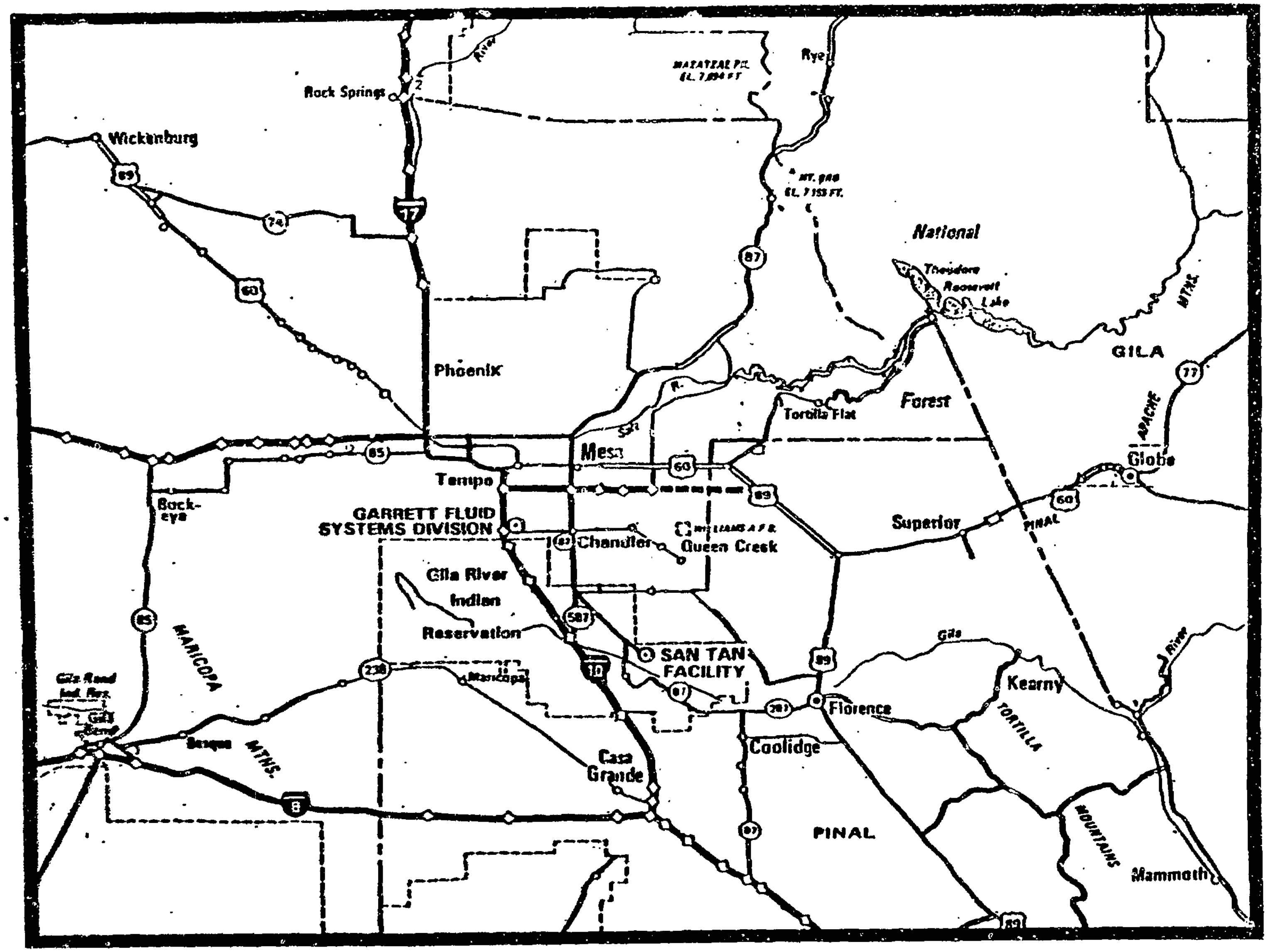

Figure 3.1-7 Location of the Garrett Facilities (U)

[redacted]

treatment, storage, and disposal (TSD) facilities, and are transported via licensed hazardous waste transporters. Infrastructure demands are met by the city of Tempe facilities.

(U) There are no recorded historic or archaeological sites at the facility, and no known threatened or endangered species are known to frequent the facility.

Activities at the GFSD San Tan Facility (U)

(U) The San Tan facility is used primarily for testing of jet and other propulsion engines. Operations include development, assembly and testing of Stored Chemical Energy Propulsion Systems (SCEPS) which use lithium as an energy source. The facility is located on a 225 acre site located approximately 1.6 km (1 mi) south of the northern boundary of the Maricopa County - Pinal County line. It is approximately 25 km (15 mi) southeast of the nearest population center of more than 50,000 persons.

(U) The San Tan Facility staff varies from 15 to 50 persons depending on test activity requirements. The facility is staffed mostly by highly trained technicians and engineers who work at the facility according to test program schedules. All of these employees are from the Phoenix and Tempe Allied-Signal Aerospace facilities. All facility support for the San Tan facility will be provided by the Tempe facility. San Tan is bounded on three sides by the Gila River Indian Reservation. The facility has little interface with the Indian community, and there are essentially no effects on tribal life-styles, cultural values, community infrastructure or demographics of the reservation.

(U) Ambient noise levels in a windy desert environment, comparable to the conditions at the San Tan facility, have been estimated at 38 dBA (DOE, 1986). Noise levels at the test pad can exceed OSHA standards and depend on the testing being performed. Fenceline noise level readings obtained during an average operational mode run of one turbofan engine provided a range of 90-96 dBA with the test cell located 38 meters (125 feet) from the fenceline (Schultz, 1990). A zone of native vegetation provides a buffer so that the fenceline noise levels are within OSHA limits. Two of the engine test stands are enclosed within the acoustically baffled structures to decrease the operating noise levels. Personnel working in the areas during testing activities are required to wear personal hearing protection (Schultz, 1990).

(U) The facility is in full compliance with all applicable environmental regulations and has an EPA ID number. The facility has written procedures for environmental operations, and has a documented personnel training program. No health and safety issues have been identified at the facility. Wastes are disposed of at licensed and approved treatment, storage and disposal (TSD) facilities.

(U) The topography at San Tan is characterized by relatively flat terrain with a general downslope to the northwest. There are no naturally occurring surface water features at the site.

(U) The exisiting electrical support system consists of a 502 kVA, 3 phase, four wire, grounded distribution system while the exisiting water capacity consists of four tanks with a total capacity of 136,000 liters (36,000 gal) (Schultz, 1991). Water distribution for the various users is

provided by a pump/piping network. All water used by the facility for testing, fire fighting, and other purposes is delivered by truck.

(U) Vegetation on the property is typical of that in the surrounding area. Most of the plants are small to medium sized native brush consisting primarily of creosote bush, bursage, ironwood and mesquite which dot the terrain. Occasional cacti including saguaros, barrel, hedgehog, and pincushions are located throughout the property (Schultz, 1990).

(U) Certain plants species are protected by agreement with the Gila River Tribal Reservation Administration. An effort is made to avoid removing saguaros and trees during construction activities. If it becomes necessary to remove a saguaro, it is typically transported to a more convenient location on site under the authority of the tribal administration. Under no condition is a saguaro destroyed. Smaller cacti may be removed and/or destroyed to make way for construction, but only when necessary. The facility property most likely encompasses the habitat of many small native animals including ground squirrels, jackrabbits, quail, lizards, desert toads, and snakes (Allied Aerospace, 1990).

(U) No threatened and endangered species are known to inhabit the San Tan site. An archaeological survey of San Tan identified no significant cultural resources anywhere on the site area (Schultz, 1990).

3.1.7 Grumman Corporation, Space and Electronics Division (U)

(U) The Grumman Corporation is a major supplier of aerospace products, electronics systems, information systems and special purpose vehicles (Figure 3.1-8). Grumman's primary facility which houses the Corporate Headquarters; the principal engineering, manufacturing, and primary assembly facilities; and the research development and testing facilities is situated on approximately 240 hectares (600 acres) in Bethpage, New York. Manufacturing operations at the facility include all machinery, equipment and processes needed to build various aircraft for commercial, U.S. Naval, and Air Force contracts. Currently there are 10,000 employees at the Grumman Bethpage facility (GSED, 1991).

(U) The Bethpage facility is in full compliance with all applicable environmental regulations. All air pollution sources have certificates to operate as required by the New York State Department of Environmental Conservation (NYSDEC). Underground storage tanks meet all county, state, and Federal regulations. The facility has written procedures for environmental operations and has a documented personnel training program. All waste generation and disposal activities within the Bethpage facility adhere to corporate procedures governing chemical disposal. The Bethpage facility has a USEPA RCRA Part B (Treatment, Storage and Disposal-TSD) Permit to store hazardous waste. Wastes not treated on site are disposed of at federally approved TSD facilities. Facility infrastructure at the Bethpage Facility is supplied by adjacent communities and is within demand capacity.

(U) There are no recorded historic or archaeological sites at the facility and no threatened or endangered species are known to frequent the Bethpage Facility (GSED, 1991).

3.2 GROUND TEST SITES (U)

(U) The three candidate ground test site locations are the Saddle Mountain Test Station (SMTS) at the Nevada Test Site (NTS), and the QUEST site and LOFT facility at the Idaho National Engineering Laboratories (INEL).

3.2.1 Nevada Test Site and Saddle Mountain Test Station (SMTS) (U)

(U) The following description of the U.S. Department of Energy's (DOE) Nevada Test Site (NTS) is primarily based on the latest NTS Environmental Monitoring Report (DOE, 1990a). The description of the proposed test location at the Saddle Mountain Test Station (SMTS) within the NTS was based on the Environmental Resource Document prepared by Sandia National Laboratories in November, 1990.

Location and Background (U)

(U) The NTS has been the primary location for testing of nuclear explosives in the United States since 1951. Historical testing at NTS included atmospheric testing in the 1950's and early 1960's, earth-cratering experiments and open-air nuclear reactor engine testing. Since 1962, all nuclear weapons tests have been carried out underground. During 1989, twelve underground nuclear tests at the NTS were announced by DOE. Radioactive and mixed waste disposal facilities for U.S. Defense waste are also operated on NTS.

(U) The NTS is located adjacent to the Nellis Air Force Range approximately 106 kilometers (65 miles) northwest of Las Vegas in southwestern Nye County, Nevada, (Figure 3.2-1). The site contains 350,000 hectares (875,000 acres) of federally owned land with restricted access. NTS is bordered on three sides by the Nellis Air Force Range, another federally owned and restricted area.

(U) The proposed Saddle Mountain Test Station (SMTS) is located near the geographic center of the NTS about 120 km (75 mi) northwest of Las Vegas in Nye County, Nevada. The site lies in an area known as Mid Valley located in the southern part of the Great Basin, a subdivision of the Basin and Range physiographic province of the western U.S. The SMTS site is on unoccupied land controlled exclusively by the Department of Energy in a region of very low population density.

3.2.1.1 Socioeconomics (U)

(U) This section summarizes the population distribution, economy, and employment of the NTS.

3.2.1.1.1 Population and Economy (U)

(U) The supporting region for the NTS is defined as Nye County and Clark County with its main population center, Las Vegas (Figure 3.2-2). The total 1988 estimated population in the supporting region was 646,800 an increase of 267,200 people since 1975. The estimated

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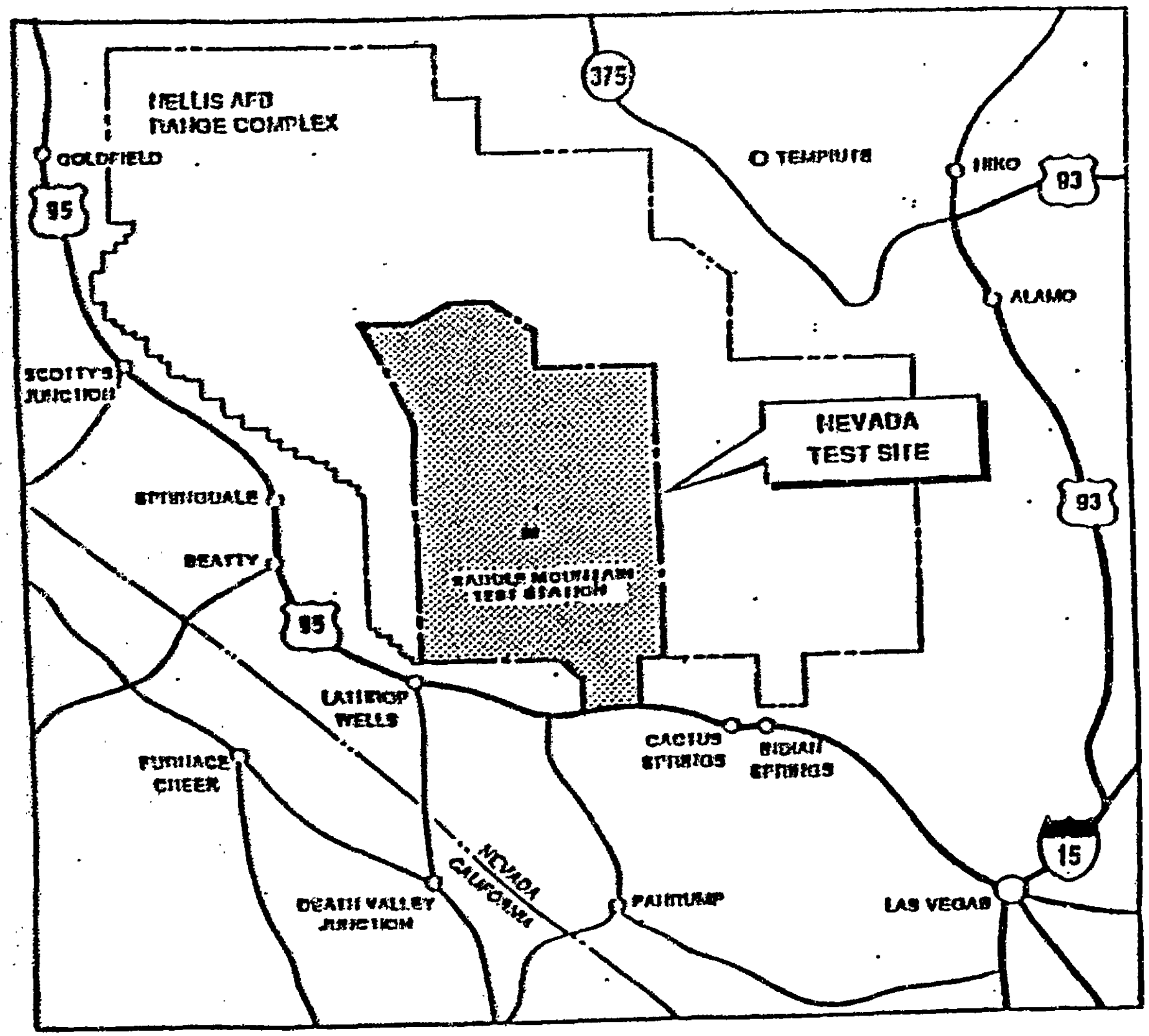
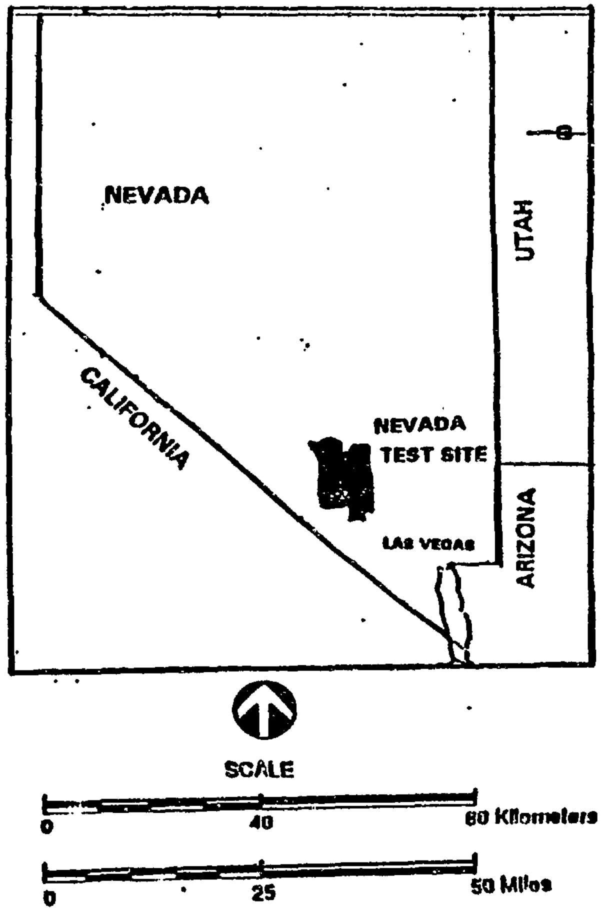
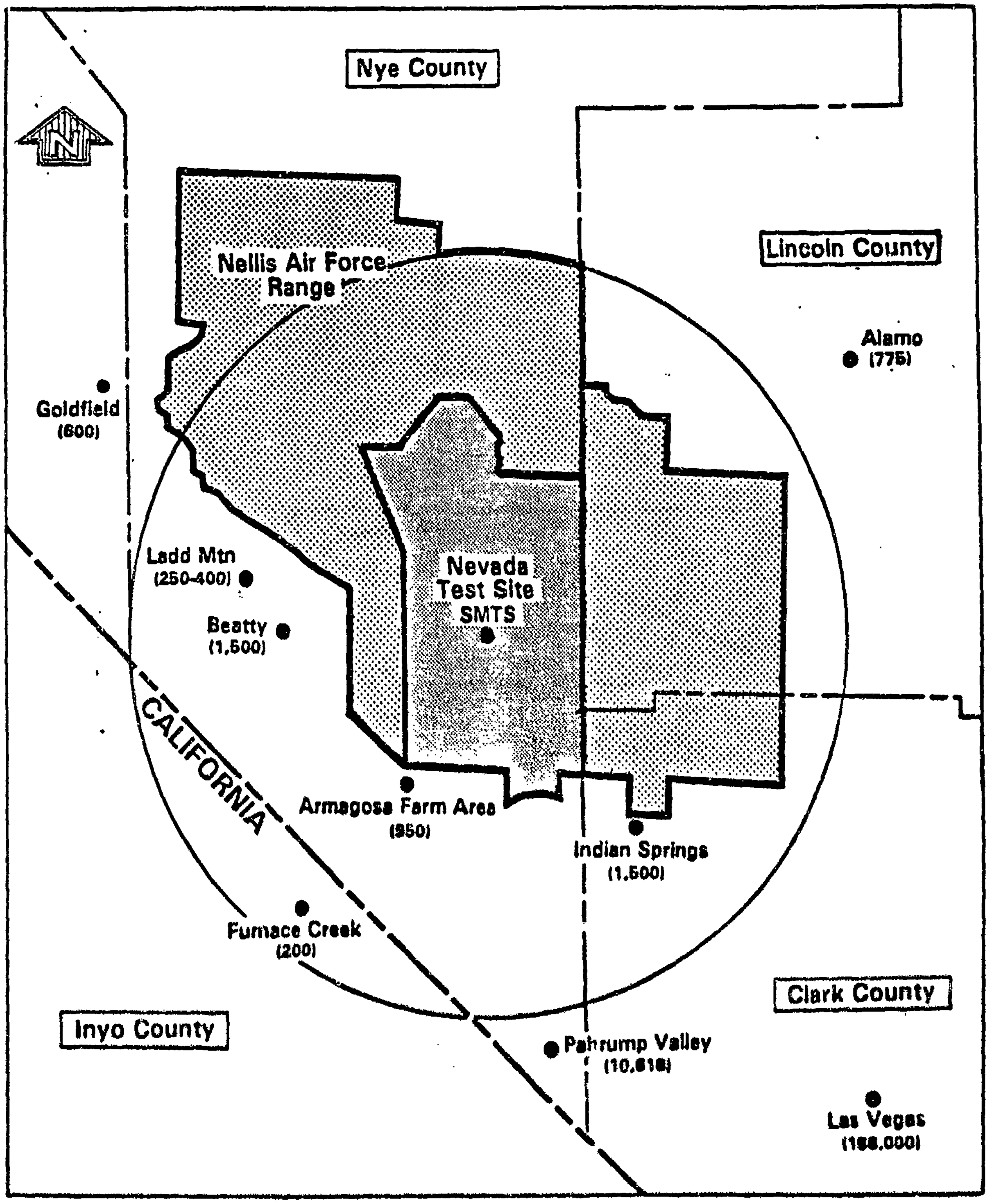




Location of Saddle Mountain Test Station at Nevada
Figure 3.2-1 (U)

[redacted]

[redacted]



Note: Only larger communities of 200 persons or greater are identified within the 80 kilometer radius

Figure 3.2-2 Population Distribution Within an 80 Kilometer Radius of the SMTS and Surrounding Areas (U)

[redacted]

average population density for Nevada in 1980 was 2.8 persons per square kilometer (REECo, 1990).

(U) The bicounty area of southern Nevada comprises two distinct social settings: (1) a rural component which includes all of Nye County and the non-urban sections of Clark County, and (2) an urban component, which includes about 96 percent of the Clark County population.

(U) The area within about 80 kilometers (50 mi) of the SMTS is predominantly rural. A number of small communities are located within this area, including Beatty, the Amargosa area, and Indian Springs. The total population within 80 kilometers (50 mi) of the SMTS, excluding the NTS, is estimated to be approximately 5,400 persons (EPA, 1991b). The population density within 80 kilometers (50 mi) of the SMTS is approximately 0.3 persons per square kilometer.

(U) The hotel, gaming, and recreation industry is one of the major economic activities in the county areas, accounting for approximately 30 percent of the total wage and salary employment in the State. Other major sources of employment and income in the NTS region include government, agriculture, mining, transportation, trade, construction and public utilities.

3.2.1.1.2 Land Use and Infrastructure

Land Use (U)

(U) The major land uses within 80 kilometers (50 mi) of the proposed test facility are (1) underground nuclear explosives testing and related activities at the NTS operated by DOE, (2) military weapons testing and personnel training at the Nellis Air Force Range, which is controlled by the U.S. Air Force; and (3) grazing, recreation, forest management on public domain lands administered by the Bureau of Land Management (Figure 3.2-3). There are also small tracts of private land used primarily for ranching activities to the southwest of the NTS.

(U) Nuclear testing activities at the NTS have included atmospheric and underground tests of nuclear explosives, nuclear reactor, nuclear engine and nuclear furnace tests; nuclear waste spill tests; and nuclear waste disposal. At present, tests are conducted at Yucca Flat, Rainier Mesa, and Pahute Mesa; these areas are located approximately 15, 30, and 40 km (10, 19, 25 mi) respectively from the proposed SMTS (Figure 3.2-4). The yield of nuclear explosives tested at the NTS is currently limited by international treaties to 150 kilotons. Non-treaty limitations to test yields, based on potential ground motion damage to off-site facilities, are 250 kilotons at Yucca Flat, and 1400 kilotons at Pahute Mesa. Buckboard Mesa, a currently inactive test site, has a 700-kiloton yield limit. Mid Valley, once identified as a potential test area, has been eliminated because of adverse hydrologic conditions.

(U) The Nevada Research and Development Area, located in Jackass Flats southwest of the proposed SMTS, was used in the past for a number of nuclear reactor, nuclear engine, and nuclear furnace tests carried out for a previous nuclear rocket program (ROVER); this program was terminated in 1972. The area is largely inactive but a number of unused test facilities remain, including an Engine Maintenance, Assembly, and Disassembly (E-MAD) facility. The

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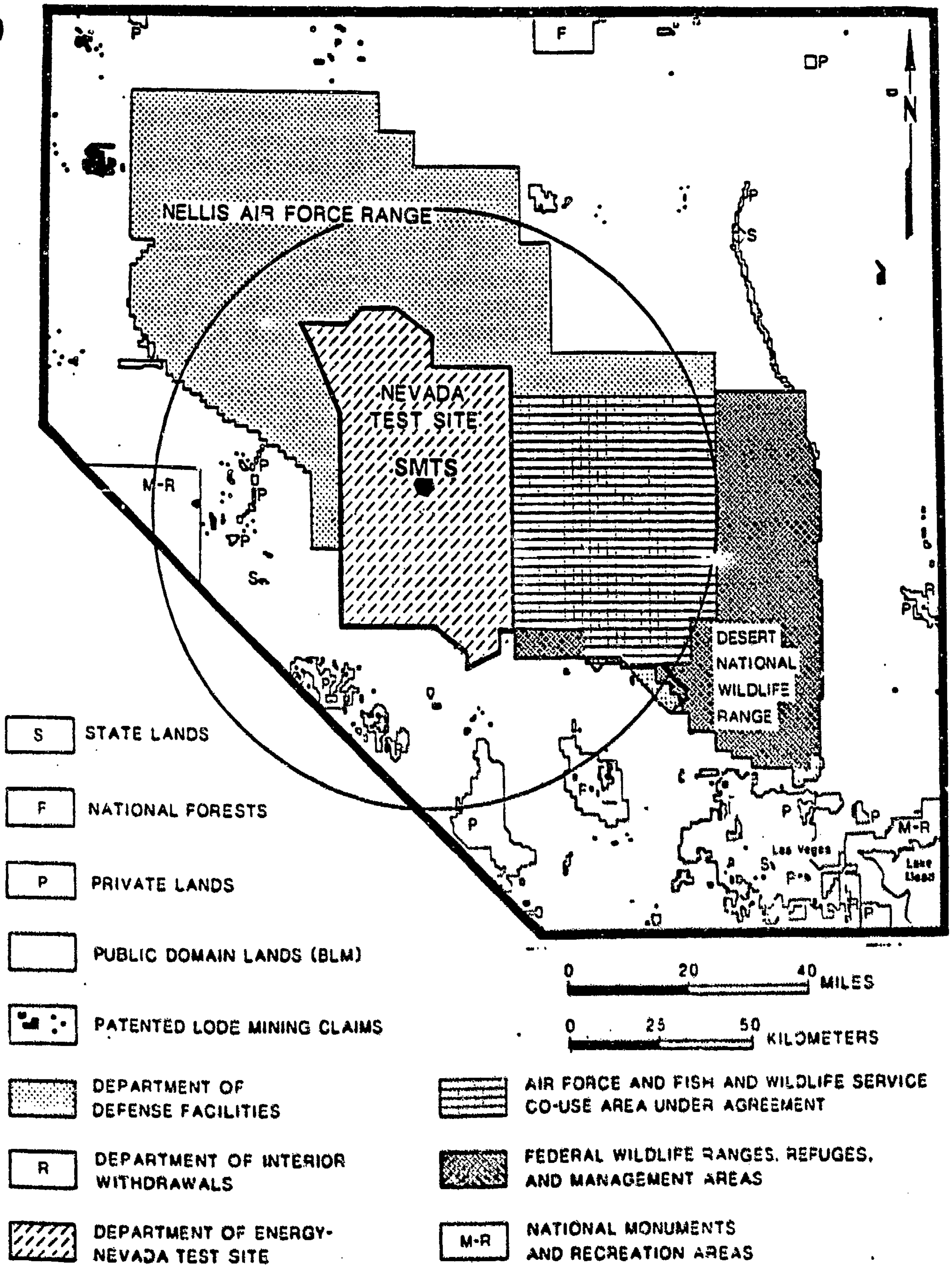

Land use in southern Nevada. Modified from Lutsey and Nichols (1972).

Figure 3.2-3 (U)

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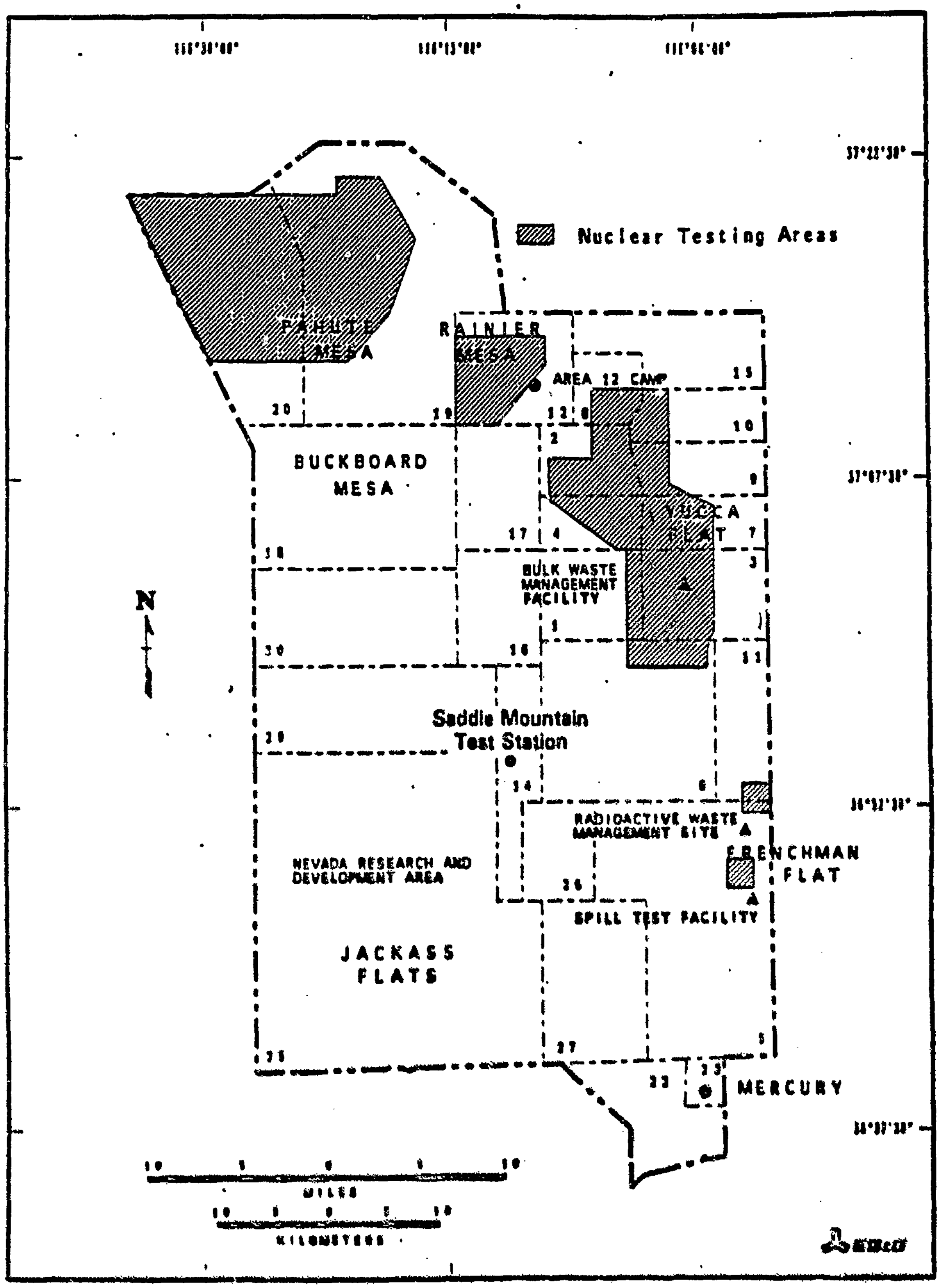

Figure 3.2-4 NTS Area Designations, Principal Facilities, and Testing Areas (U)

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remains of a rocket motor test facility are also located 3 km (2 mi) from the SMTS at Mine Mountain Junction.

(U) Yucca Mountain, approximately 30 km (19 mi) southwest of the proposed SMTS site, has been designated for site characterization to determine suitability for development of a geologic repository for the permanent disposal of commercial spent nuclear fuel and defense high-level radioactive waste. If constructed, the repository would consist of a large underground complex of rooms and tunnels in which the waste would be permanently stored, isolated from the outside environment.

(U) The Nellis Air Force Range is used primarily for bombing and gunnery training. East of the NTS, the Nellis Air Force Range is jointly managed by the Air Force and the Fish and Wildlife Service as the Desert Game Range.

(U) The proposed SMTS is currently unoccupied. The nearest facilities are a radio transmitter and receiver located on Shoshone Mountain about 3.5 km (2 mi) to the west (Figure 3.2-5). Primary access to the site is via the Mine Mountain and Saddle Mountain Roads from the east and north, respectively.

Infrastructure (U)

(U) This section provides data on education, health services, public safety, public and municipal services, and transportation within the NTS supporting region.

(U) Education: In Nye county, two of the elementary schools, a junior high school, and one of the high schools are located in Tonopah. Other communities having secondary schools are Beatty, Gabbs, and Pahrump. There are no private schools in the county. Of the Clark County schools, 66 elementary, 17 junior high, 10 senior high, and 2 special education schools are located in the grater Las Vegas area. Also located in Clark County are the University of Nevada, Las Vegas (UNLV), and Clark County Community College.

(U) Health Services: The health services in the NTS area are limited. All Nye County and parts of Clark County have been ranked as a priority 1 health-manpower-shortage area by the U.S. Public Health service, meaning that it has the highest priority for allocating health manpower recruited by the Health Services Corps. (DOE, 1986).

(U) Public Safety: The Nye County Sheriff's office provides police protection for the entire county except for the city of Gabbs. There were about 3.53 commissioned police officers for every 1,000 people in the county in 1982. This relatively high ratio is explained in part by large area of the county and the long distances between towns. Clark County is served by 893 police officers for a total population of 535,150 (1983).

(U) Public and Municipal Services: Social services in southern Nevada are provided by a variety of State and local agencies. The Nevada Department of Human Resources administers various programs for social services. There are many library and recreational facilities located throughout the two county region. Power and waste disposal services are all provided.

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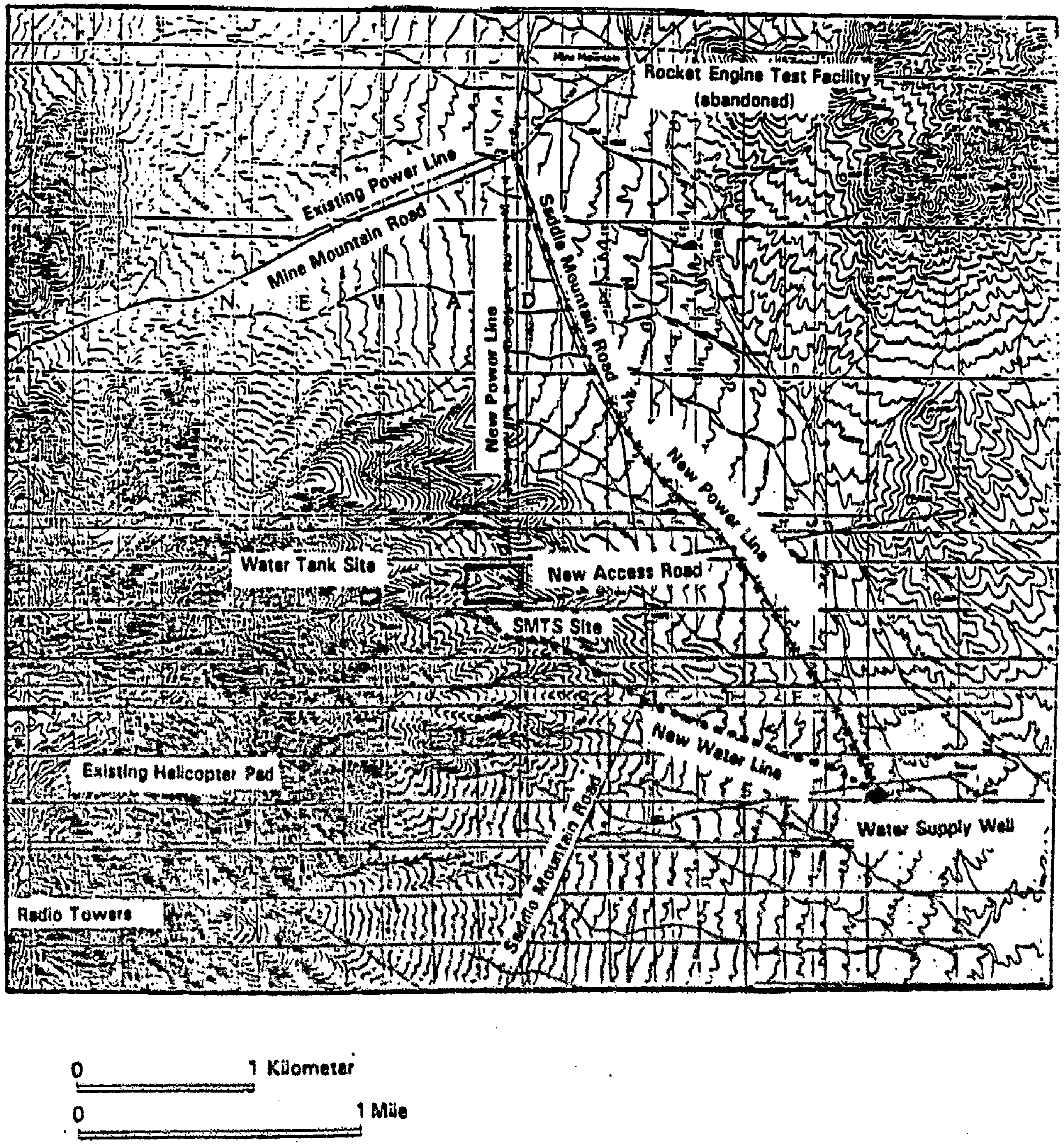

Figure 3.2-5 Topography of Saddle Mountain Test Station (U)

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(U) Transportation: There are a total of 38 airports in the four county region surrounding the NTS. Most of the runways are unpaved with few or no facilities and services. U.S. Highway 95 from Las Vegas to Tonopah forms part of the southern boundary of the NTS. There is one entrance to the NTS from Highway 95. The northern entrance to NTS is accessible from state highway 375 located 34 km (21 mi) to the northeast (Figure 3.2-1).

3.2.1.1.3 Noise (U)

(U) The major sources of noise at the SMTS are natural physical phenomena such as wind and rain, and the activities of wildlife. Average annual wind speed at the Mid Valley Station ranges from 6-8 mph. For noise assessment purposes, this area would be considered windy. Desert noise levels as a function of wind have been measured at an upper limit of 22 dBA for a still desert and 38 dBA for a windy desert.

3.2.1.1.4 Historic and Archaeologic Resources (U)

(U) Human habitation of the NTS area dates from as early as 10,000 B.C. to the present. Various aboriginal cultures occupied the NTS area over this extended period as evidenced by the presence of artifacts at many surface sites and more substantial deposits of cultural material in several rock shelters. The area was occupied by Paiute Indians at the time of the first outside contact in 1849. This period of aboriginal occupation was sustained primarily by a hunting and gathering economy, based on using temporary campsites and shelters (DOE, 1990a). Archaeological remains include artifacts found on or just below the surface at campsites and in natural caves or rockshelters in canyons and cliff faces. The artifacts comprise flakes and ground stone tools, pottery (mostly shards), and occasionally trade items, such as glass beads, indicative of post contact occupation (DOE, 1977).

(U) Many small surface assemblages of prehistoric stone artifacts are found scattered throughout the Mid Valley area. A reconnaissance survey of the proposed SMTS site recorded five small surface sites, three along the proposed road segments, in the center of the facility area, and along the proposed power line corridor. These sites have been collected and the DOE has determined that these sites are not eligible for the National Register. Concurrence from the State Historic Preservation Officer has been received (Appendix F).

(U) A number of cultural sites have been identified during an archaeological reconnaissance conducted surrounding the exploratory well drill pad southeast of the SMTS (DRI, 1983). Two sites that were in close proximity and were likely to be disturbed by activities at the drill pad were recorded and collected according to Bureau of Land Management (BLM) standards for small sites. Site S103183MV14, located approximately 1 km (0.5 mi) from the drill pad, was considered eligible for nomination to the National Register (Appendix F).

(U) Guidelines and operating procedures have been developed at the NTS to protect known sites of potential archaeological and historic interest in compliance with the Federal Antiquities Act of 1906 (16USC Sections 431, 432, 433), the Historic Sites Act of 1935 (16USC Sections 461 and 467), and the National Historic Preservation Act of 1966 (16USC Section 470). These procedures have been established in the standard operating procedure for the NTS (NTS SOP

5407 - "Preservation of Antiquities, Historical Sites, and Threatened or Endangered Plant Species") which specifies the responsibilities and procedures to be used with regard to preservation of antiquities and historic sites within the NTS. It also establishes procedures for reporting and confirming new "finds" of archaeological and historical interest.

3.2.1.1.5 Safety (U)

Nevada Test Site Safety (U)

Policy (U)

(U) The Department of Energy policy requires establishment of radiation protection standards commonly applicable to all DOE personnel, DOE contractors, and other NTS users. This policy further requires that all test site operations be conducted in a manner to assure that exposure of individuals, both on-site and off-site populations, to ionizing radiation is limited to the lowest levels technically and economically achievable. The requirements of DOE Orders and 10 CFR 20 are applicable. The DOE policy is to keep occupational exposures of personnel as low as reasonably achievable (ALARA).

(U) Currently the maximum permissible exposure standards for occupational workers are set forth in DOE Order 5480.11, Paragraph IX, "Requirements for Radiation Protection." This policy establishes two categories within the work force: monitored workers subject to occupational exposure standards, and general site workers administratively controlled to 1/10 the occupational exposure standards. NTS users are responsible for assuring that the system of personnel dosimetry supplied by the DOE contractor is properly used by their staff (DOE, 1988c).

Safety Analysis Reports (U)

(U) Individual safety analysis reports (SARs) will be written for each program test series to be conducted at the Nevada Test Site. They follow the format of "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," USNRC Regulatory Guide 1.70. The preliminary SARs will be reviewed and approved by DOE/NVO before submission to DOE/HQ (Appendix B).

(U) The sponsoring laboratory or agency provides radiological safety plans for each test series to the Test Controller for approval. Plans are submitted to cover all operations. They include radioactive effluent documentation, personnel monitoring at drill rigs, surveys for radiological safety, re-entry procedures for both vertical hole and tunnel tests, cleanup and pollution control procedures, instrumentation types and deployment, and any other radiological safety features pertinent to operations at the NTS.

(U) The Off-Site Radiological Safety Office (EPA/EMSL) is responsible to the Test Controller and the NTS Manager for providing off-site radiological safety services in accordance with NTS-SOP 5402 and the Interagency Agreement (DE-AI08-86-NV10522). Emergency preparedness responsibilities as outlined in DOE Orders 5500.2 and 5480.1A, along with NTS-SOP 5501, are

complied with. All essential test-related personnel receive basic radiological safety training.

(U) Documented standard operating procedures have been established for radiological testing activities that are conducted at the NTS. The Radiation Safety Manual for the NTS outlines standard operating procedures for radioactive materials control, shipment of radioactive material, radiological safety in specific test areas and waste management (DOE, 1988c).

(U) The perimeter of the NTS is not fenced, but is posted as a restricted area, and access is prohibited other than at designated entrances. Road access to the NTS is restricted by guard stations and barricades. A guard station exists at the Mercury entrance and at the northern entrance from Highway 25. Mobile patrols are employed to provide security over the large area. All personnel on the NTS are required to be badged (identification and film badges). Generally, workers at the NTS are required to have a security clearance (DOE, 1977b).

(U) Temporary roadblocks are established when needed to control access to designated testing areas in connection with the detonation of underground nuclear devices. The designated forward areas usually include all areas north of the Control Point, and these areas are "swept" by guard patrols to assure that all personnel have withdrawn to a safe designated location. Helicopters and light aircraft are available to the security force and are normally used to check perimeter barricades and other remote locations in the forward test areas as a part of this sweeping action.

3.2.1.1.6 Waste (U)

(U) All waste management activities at NTS are regulated by applicable federal, state, and local laws and regulations as well as DOE requirements. Existing waste handling facilities at NTS are located at the Radioactive Waste Management Site (RWMS) in Area 5 of the NTS and the Bulk Waste Management Facility (BWMF) in Area 3 of the NTS (Figure 3.2-4). The Area 5 RWMS is used for low-level wastes (LLW) disposal, mixed wastes (MW) disposal, transuranic wastes (TRU) storage, hazardous waste accumulation, and classified waste disposal. Bulk LLW that cannot be packaged, such as contaminated soil and metal from on-site activities, are disposed of at the Area 3 BWMF.

(U) Transuranic (TRU) wastes are stored in a TRU storage pad at the Area 5 RWMS in preparation for transfer of the waste to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The current volume of TRU is approximately 600 m^3 (21,000 ft^3) (DOE, 1990d). The estimated remaining capacity of the TRU storage pad is approximately 1,000 m^3 (35,000 ft^3) (DOE/NVO, 1990c).

(U) Low level wastes (LLW) which qualify as Defense Wastes as specified in DOE Order 5820.2A (Radioactive Waste Management) are managed in accordance with NVO 325 (Nevada Test Site Waste Acceptance Criteria, Certification, and Transfer Requirements) as revised in October 1988. The total volume of LLW disposed of at the Area 5 RWMS between 1961 and 1988 was 400,000 m^3 (14 million ft^3) (DOE/NVO, 1990c). The RWMS site occupies about 732 acres, of which 37 hectares (92 acres) are currently in use for waste disposal. Between 1974 and 1988, 208,000 cubic meters of contaminated material were consolidated at the Area 3 BWMF. The estimated remaining capacity for solid LLW at the NTS is approximately 500,000

m^3 (17.7 million ft^3) with an estimated annual input of 25,000 m^3 (880,000 ft^3) (DOE/NVO, 1990c). There is no existing capacity for liquid LLW (DOE/NVO, 1990c).

(U) To provide disposal capacity for mixed waste (MW), the DOE Nevada Operations Office has obtained interim operating status for a Mixed Waste Management Unit (MWMU) at the Area 5 Radioactive Waste Management Site (RWMS). MW are managed by Reynolds Electrical and Engineering Co., Inc. (REECo) in accordance with the Resource Conservation and Recovery Act (RCRA) Part B, Permit Application for Generation of Hazardous Waste and Mixed Waste Disposal (NV 389 009001) (DOE 1990d). DOE/NVO has applied for a part B permit from the state of Nevada for disposal of mixed waste (DOE, 1990d). To date, approximately 5,700 m^3 (200,000 ft^3) have been emplaced (DOE, 1990a). The MWMU is to be operable for five years or until 150,000 m^3 (5.3 million ft^3) of MW has been accumulated, whichever comes first (DOE, 1990). The annual input of mixed waste to the MWMU is approximately 20,000 m^3 (700,000 ft^3). The draft Safety Analysis Report for the Area 5 RWMS is being updated and an Environmental Assessment is in preparation.

(U) Hazardous wastes generated by activities at the NTS are managed by REECo in accordance with RCRA Part B (NV 389 009001) (DOE 1990d). These wastes are collected at the local testing facility up to a specified limit of 210 liters (55 gal) per waste stream and then transferred to the Area 5 Hazardous Waste Accumulation Pad for ultimate disposal to an EPA-approved off-site treatment, storage and disposal facility prior to the 90 day storage limit. Approximately 100 m^3 (3,500 ft^3) of hazardous waste are generated from NTS activities each year.

(U) Nonradioactive nonhazardous waste solid waste is disposed of in the sanitary landfill located at in Area 23 and Area 9 of the NTS which is permitted by the state of Nevada. The Area 23 and Area 9 landfills are anticipated to be operational for an additional 10-12 years and 15 years respectively (DOE/NVO, 1990c). Waste water effluents are discharged to ponds and lagoons as authorized by a series of state of Nevada permits (DOE, 1990d).

3.2.1.2 Physical Environment (U)

(U) This section provides information on topography, geology, and seismic activity of NTS and SMTS.

3.2.1.2.1 Topography (U)

(U) The topography of the Nevada Test Site is typical of much of the Basin and Range physiographic province. There are numerous north-south trending, linear, rugged mountain ranges separated by broad, flat-floored and gentle-sloped valleys. Elevations range from 910 to 1,370 meters (3,000-4,500 ft) in the valleys to the south and east, rising to 1,700 to 2,100 meters (5,500-6,900 ft) in the high country toward the northern and western boundaries.

(U) The SMTS site is located in an interchannel area of an inactive alluvial fan in the western part of the lowland known as Mid Valley. Slopes at the site area range from 5% in the interchannel area to 25% along stream channels that are incised to depths of 20 to 25 meters (60 to 80 ft). The site elevation is about 1470 meters (4840 ft) above MSL. To the southeast, the

land slopes gradually down to the center of Mid Valley where the existing water-supply well is located about 150 meters (500 ft) in elevation below the site; to the west slopes steepen as the land rises abruptly to the rugged crest of Shoshone Mountain more than 600 meters (2,000 ft) in elevation above the site.

3.2.1.2.2 Geology (U)

(U) The geology of the Great Basin is characterized by alternating sequences of folded and faulted Paleozoic sedimentary rocks overlain by thick layers of tuffaceous volcanic rocks of Tertiary age. Bedrock is exposed in block faulted mountains; in lowlands and valleys, bedrock is covered by thick alluvial deposits of Quaternary age. Shoshone Mountain is a typical small fault-block mountain; Mid Valley is a typical small alluvium-filled lowland.

(U) The proposed SMTS site (Figure 3.2-6) is underlain by older alluvial fan deposits of Quaternary age; these deposits consist of unconsolidated and weakly consolidated mixtures of cobbles and pebbles of welded tuff and limestone in a matrix of silt and sand (Orkild, 1986). Occasional large boulders are found at or near the surface. The percolation rate at the site averages 37 minutes per inch. At various depths the materials are cemented by calcium carbonate into hard concrete-like layers (caliche). These older alluvial materials are estimated to be less than 60 meters (200 feet) in thickness over bedrock at the proposed site. Toward the center of Mid Valley to the east in the areas traversed by the proposed water and power lines serving the water supply well, thick deposits of younger alluvial deposits consisting of unconsolidated boulders, cobbles, pebbles, and sand conceal the underlying bedrock. Within half a kilometer to the west, folded and faulted beds of dolomite and limestone of Devonian age are exposed on the flank of Shoshone Mountain. Hard layers of welded tuff and tuffaceous rocks of Tertiary age crop out at the crests of the mountain.

(U) Typical of the geologic structure of much of the Great Basin, bedrock is cut by several steeply dipping normal faults along the western boundary of Mid Valley. These faults are concealed beneath alluvial deposits at the proposed test facility; their locations are approximated by extension from observed faults to the north and the south. Geologic evidence has been cited indicating that 32 other faults in the general area have involved Quaternary deposits; date of latest movement on these faults have ranged from 40,000 to 2 million years ago (DOE, 1986). No information is available on the latest date of movement on the concealed faults that underlie the proposed SMTS site.

(U) Underground nuclear explosions at the NTS have caused minor displacements along preexisting faults elsewhere in the NTS. The prominent Yucca fault in Yucca Flat has ground-shock-induced displacement by nuclear explosions along most of its length of 25 kilometers (15 mi). The vertical displacement of the Yucca fault at the ground surface is mostly less than 0.3 meter (1 foot), but at a few places it is displaced as much as 0.5 meter (1.5 feet). Preexisting faults on Pahute Mesa characteristically exhibit displacement from nuclear explosions, resulting in vertical offsets of about 0.3 meter (1 foot) or less for distances along the fault of as much as 5 kilometers (3 mi). No evidence of any such ground-shock-induced displacements has been reported in the Mid Valley area.

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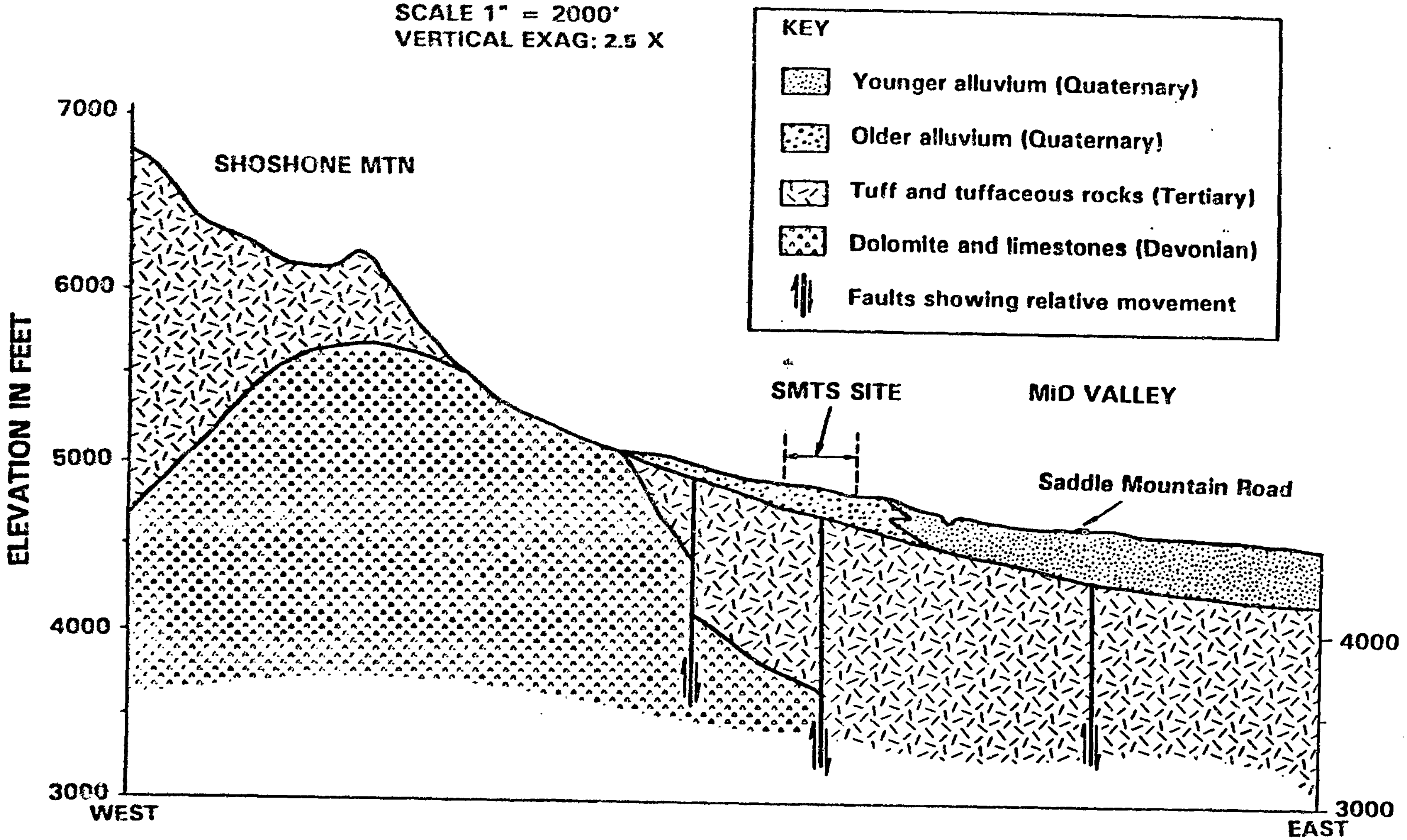

Schematic geologic cross section in vicinity of proposed Saddle Mountain Test Station (Based on Orkild, 1986).

Figure 3.2-6

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3.2.1.2.3 Seismic and Volcanic Activity (U)

Seismic Activity (U)

(U) The area of the proposed SMTS is subject to ground accelerations resulting from naturally occurring (tectonic) earthquakes and induced earthquakes resulting from underground nuclear explosions carried out elsewhere at the NTS.

(U) Mid Valley lies in an area of relatively low historical seismicity and is assigned to seismic risk zone 2 (Moderate damage) of the Uniform Building Code (UBC). However, due to the activity induced by the underground testing, all structures at the NTS need to conform to the requirements of UBC Zone 4. Available data suggest that earthquakes with magnitudes < 4.5 Richter occur with a frequency of less than one per year within 40 km (24 mi) of the proposed site. The nearest recorded larger earthquake occurred in 1949, had a magnitude of 5.6, and was centered 130 km (80 mi) to the west. Peak ground accelerations from tectonic earthquakes in southern Nevada have not exceeded 0.5 g.

(U) Over geologic time, earthquakes in the Southern Great Basin have occurred in relatively brief episodes of intense activity in areas that may have been inactive for hundreds or thousands of years. Although earthquakes in the region are commonly associated with Tertiary faults that bound fault-block mountains, there is no information suggesting that any historic earthquakes have been associated with the faults underlying Mid Valley. In any case, current knowledge of Quaternary faulting is not considered sufficient to permit reliable correlations of earthquakes with tectonic processes such as faulting (DOE, 1986).

(U) An unavoidable consequence of underground testing of nuclear explosives is the generation of ground motion and shock waves which at distances resemble natural earthquakes. The characteristics of such ground motion depends on the yield and depth of the explosion and the geologic and hydrogeologic environment of the test location. Experience has shown that yields above 100 kilotons may cause minor architectural damage in nearby communities. SNL has initiated a seismic monitoring program to monitor the seismic response of the SMTS to underground nuclear tests as well as to natural seismic events. Data from two recent large underground tests show maximum ground accelerations of 0.003g and 0.1g in the vicinity of the site (SNL, 1991e and SNL, 1991f). Data from these and from future events will be used to refine seismic design criteria for the SMTS.

Volcanic Activity (U)

(U) Widespread past volcanic activity in the southern Great Basin suggests the possibility of future volcanism in the region. Past activity in the area of the SMTS has included both explosive ash-producing volcanoes, as evidenced by the tuffaceous rocks underlying the site, and numerous Quaternary lava flows that are found elsewhere in the region. The most recent explosive volcanic activity in the area occurred more than seven million years ago at Black Mountain located 45 kilometers (28 mi) northwest of SMTS. The most recent lava flows in the area occurred an estimated 140 thousand years ago at the Lathrop Wells volcanic center 35 km (21 mi) southwest of the SMTS (Turrin, 1991).

3.2.1.2.4 Water Resources (U)

(U) The hydrology of the NTS has been studied intensively since the mid-1950's, and water quality in and around the site has been monitored since underground nuclear testing began. The U.S. Geological Survey, the Environmental Protection Agency, and the Desert Research Institute of the University of Nevada have conducted most of these studies.

(U) Surface Water: Surface water in the southern Great Basin occurs principally in interior drainage systems characterized by a dense network of intermittent streams that flow into closed topographic basins known as playas. Typically this water stands on the playas for several days to a few weeks before it is lost, mainly by evaporation. There are 13 playas within a radius of 80 km (50 mi) of the proposed SMTS site.

(U) There are no perennial sources of surface water in the Mid Valley area. The nearest perennial body of surface water is Lake Mead 150 km (90 mi) to the east. The alluvial fans on which the proposed SMTS site is located is cut by many shallow boulder-dry stream beds that contain water only during and shortly after occasional heavy rains. During rare flash floods streams may be diverted by sediment and cut new channels into easily eroded alluvial deposits. There is, however, no evidence of such flash flooding in the channels bordering the proposed site. Runoff from the precipitation at the proposed site drains into the normally dry Barren Wash which is part of an interior drainage network that terminates in Frenchman Flat, a playa in a closed topographic basin about 25 km (16 mi) to the east. Surface water drainage from the proposed SMTS site, therefore, does not flow beyond the boundary of the NTS.

(U) Groundwater: The groundwater hydrologic systems of the southern Great Basin are characterized by deep water tables and closed ground water basins that may not correspond to topographic basins. Recharge occurs predominantly by slow percolation from upland areas through the unsaturated zone that overlies the water table. Ground water in the region occurs chiefly in fracture zones in at least six major aquifers at various levels within limestone, dolomite, and volcanic rock units. The aquifers are commonly isolated from each other by aquitards, relatively impermeable layers that act as a barrier to ground water movement. In addition, ground water flow is commonly blocked or diverted by faults and in places where the ground water reaches the surface as flowing springs. In the deeper aquifers, the water is under artesian pressure.

(U) In the Mid Valley area, ground water occurs only in deep bedrock aquifers; the alluvial deposits may contain water following rains but do not form perennial aquifers. Ground water in the proposed water-supply well occurs in tuff aquifers that are probably isolated from the deeper limestone and dolomite aquifers. The static water level in this well is at a depth of 507 meters (1663 feet) below the surface; the well head is at an elevation of 1325 meters (4346 feet). Principal recharge areas for the bedrock aquifers are upland areas and mesas to the north.

(U) Water use in Nevada is governed by the office of the State Engineer and the Division of Water Resources. Chapter 534 of the Nevada Water Laws outlines and delineates the allowable uses of ground waters. Total annual ground water withdrawals from any given basin may not exceed the perennial yield. Ground water in the Mid Valley area is believed to be part of the

Ash Meadows subbasin (Figure 3.2-7). There are 12 NTS wells that currently withdraw water from the Ash Meadows subbasin for construction, drilling, fire protection, and consumption uses (DOE, 1988d). Data collected from wells located in Areas 3, 5 and 6 of the NTS indicated that there has been no detectable decline in the static water level and therefore no exceedence of perennial yield for the aquifer(s) at these locations (DOE, 1988d) (Note; refer to Figure 3.2-4 to observe the locations of NTS Areas 3, 5, and 6 in relation to the SMTS). Total withdrawals from well C and C-1 located in Area 6 of the NTS were 26 million gallons (98 million litters) per year each (DOE, 1988d).

(U) Water Quality: Groundwater from the tuffaceous aquifers such as those in the proposed water-supply well is generally of excellent chemical quality. It is characterized by relatively high concentrations of sodium and potassium carbonates and low acidity. Groundwater sampled from a borehole approximately 30 km (20 mi) southwest of the SMTS had a pH of 7.7, 216 milligrams per liter of dissolved solids, and relatively high concentrations of silica (45 milligrams per liter), sodium (57 milligrams per liter), and bicarbonate (143 milligrams per liter). In general, water in the tuffaceous aquifers meets U.S. Environmental Protection Agency secondary standards in major cations and anions and the primary standards for harmful constituents (DOE, 1986). There are no known incidents of groundwater contamination (e.g. fuel spills, solvents) in the vicinity of the SMTS location.

(U) The deep aquifers, slow groundwater movement, and exceedingly slow downward movement of water in the overlying unsaturated zone serve as barriers to transport of radioactivity from underground sources (e.g. underground testing) via groundwater, preventing movement of radioactivity to off-site areas for thousands of years. The estimated average velocity of groundwater flow through the lower carbonate aquifer in central Yucca Flat is from 2 to 180 meters (6 to 600 ft) per year (DOE, 1990a).

(U) Groundwater is the only local source of drinking water in the NTS area. Drinking and industrial water-supply wells for the NTS produce from the lower and upper carbonate aquifers, the volcanic aquifer, and the valley-fill aquifer. Though a few springs emerge from perched groundwater lenses at the NTS, discharge rates are low, and spring water is not currently used for DOE activities. South of the NTS, private and public supply wells are completed in the valley-fill aquifer.

3.2.1.2.5 Meteorology and Air Quality (U)

(U) The southern Great Basin area has a desert climate characterized by cool winters, hot summers, low rainfall, and generally predictable winds.

(U) Summer temperatures generally range between 24° and 35° C (75-95° F); extreme summer temperatures reach 43° C (110° F). Average winter temperatures range from 2° to 14° C (35°-57° F); extreme low temperatures reach -14° C (7° F). Temperature inversion layers are low during night and mornings and rise during the day by surface heating. Average annual precipitation in the area is about 4 inches occurring principally in winter and during occasional summer thunderstorms.

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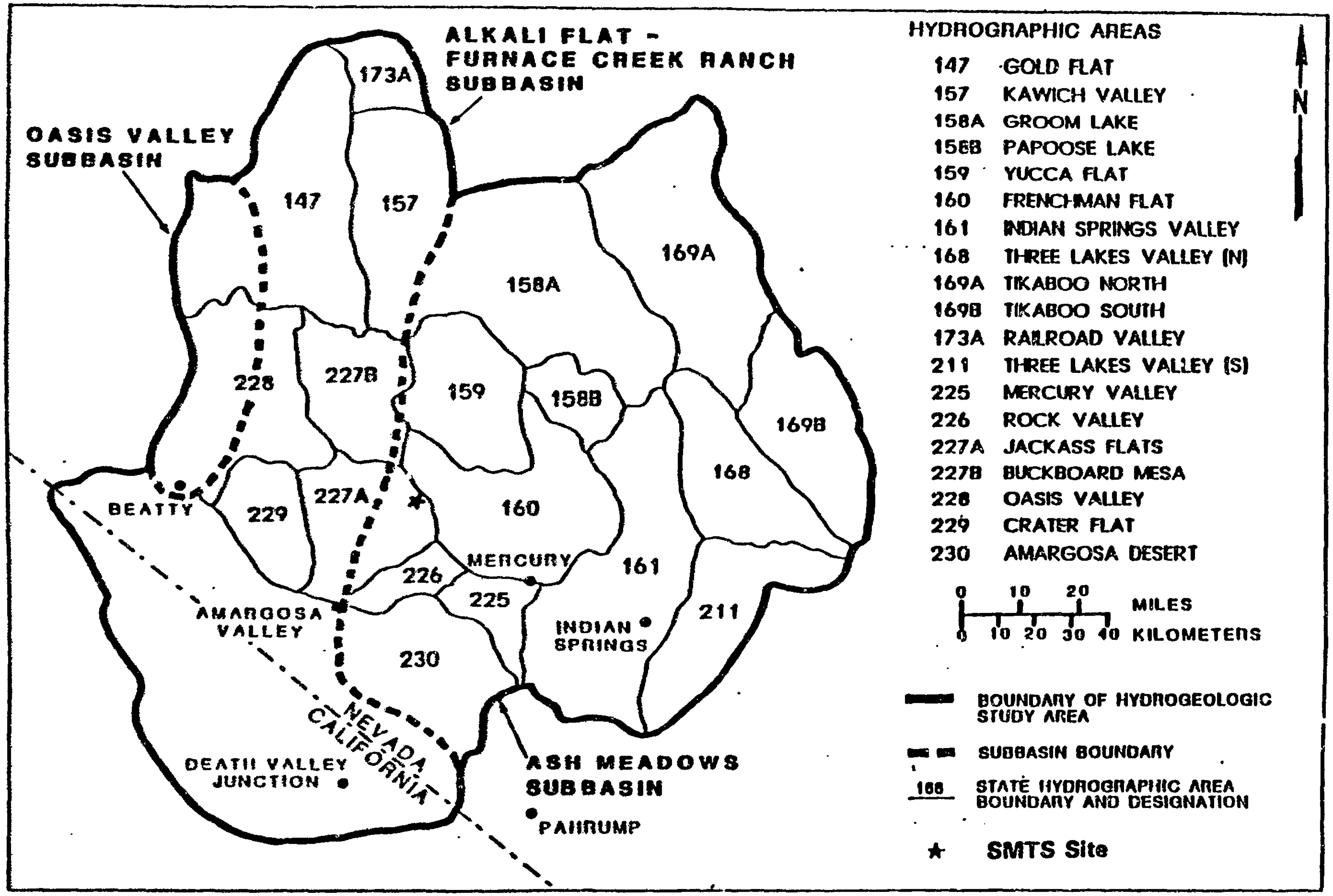

Location of the SMTS with respect to the relevant hydrographic areas of death Valley ground-water system and the hydrogeologic study area. Modified from Scott et. al (1971).

Figure 3.2-7 (U)

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(U) Wind direction and wind speed is an important aspect of the environment at the NTS. These are the major factors in planning and conducting nuclear tests, where atmospheric transport is the primary potential route of contamination transport to on-site workers and off-site populations. The movements of large-scale pressure systems control the seasonal changes in the wind direction frequencies. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north/south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime associated with large-scale pressure systems. This scenario is very sensitive to the orientation of the mountain slopes and valleys.

(U) Air movement in the area of the proposed SMTS is typical of NTS valleys. Predominate winds in the winter are northwesterly, in the summer southwesterly, and in the spring and fall westerly. Daily variations typically are southwesterly in early afternoon and northerly after sundown to midday. The cool evening flow is down slope to Frenchman Flat (DOE, 1990a). Monthly average winds, as measured at MEDA 14 (Mid Valley Station) range from 3-4 m/s (6-8 mph) (with a lower average occurring in the winter months and higher in the summer months. Maximum wind velocity recorded (1983-1988) is less than 25 m/s (50 knots or 57.5 mph).

(U) The vertical thermal structure of the atmosphere at NTS is typical of the southern Great Basin. The vertical thermal structure of the portion of the atmosphere next to the ground is important in enhancing or restricting the vertical diffusion of airborne materials. The mixing depth is that portion of the atmosphere where airborne materials can diffuse freely. An inversion layer marks the upper boundary of the mixing depth, above which airborne materials do not diffuse freely. In most regions, the height of the inversion layer has large variations both seasonally and diurnally. In the NTS region, the mean height of the inversion layer above the ground surface during morning hours ranges from about 300 to 600 meters (1,000 to 2,000 ft) for all seasons of the year; during afternoon hours, it ranges from about 2,000 to 3,600 meters (6,500 to 11,800 ft) except in winter when it is in the 1,000 to 1,400 meter (3,300 to 4,600 ft) range (Holzworth, 1972).

(U) The air quality at SMTS is in attainment for pollutants regulated by the state of Nevada and Federal air quality standards. SMTS is located within the Nevada Intrastate Air Quality Control Region 147 (AQCR-147). The nearest nonattainment area for CO (Carbon Monoxide) and TSP (Total Suspended Particulates) is the Las Vegas Valley in AQCR-013 approximately 120 km (75 mi) southeast of SMTS (40 CFR 81.329).

(U) Currently, there are no activities in SMTS that would disturb the air quality other than occasional vehicle traffic on the Mine Mountain and Saddle Mountain Mid-Valley roads. This traffic, primarily security patrol and Shoshone Mountain microwave station maintenance vehicles, causes a temporary increase in suspended dust particles arising from the dirt/gravel road.

(U) There are no criteria pollutant or prevention of significant deterioration (PSD) monitoring requirements for NTS operations. Clean Air Act compliance requirements were limited to asbestos and radionuclide monitoring and reporting under National Emissions Standards for

Hazardous Air Pollutants (NESHAP). Air pollution sources common at the NTS include aggregate production, stemming activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities (DOE, 1990d).

(U) The national and Nevada Ambient Air Quality Standards are shown in Table 3.2-1. The Desert Research Institute (DRI) collected ambient air quality data 70 km (44 mi) northeast of Las Vegas as part of the permitting process for a power plant expansion (DRI, 1979). Due to the limited amount of development in the region and the lack of industrial sources, these values can be considered to be representative of the ambient air quality conditions at the SMTS. Concentrations of SO_2 were observed to be below 23 ug/m^3; monthly average NO_2 concentrations never exceeded 17 ug/m^3; and ozone showed an expected seasonal trend, with one hour concentrations as high as 173 ug/m^3 in the late spring and early summer and 60 ug/m^3 in the winter. Daily TSP concentrations were observed to vary between 8 and 123 ug/m^3 with an annual geometric mean of 30 ug/m^3 (DOE/NVO, 1990c).

(U) Previous nuclear testing operations have been conducted in accordance with the NESHAP radionuclide emissions of 10 millirem/year effective dose equivalent at off-site locations. Calculated maximum off-site dosage using the EPA model AIRDOS/RADRISK is approximately 0.00015 mrem/year for all radionuclides, which represents only 0.002% of the NESHAP standard (DOE, 1990a).

3.2.1.3 Biological Resources (U)

(U) This section includes a discussion of the flora and fauna found at the NTS with a brief discussion of biological resources at the SMTS.

3.2.1.3.1 Terrestrial (U)

(U) The NTS encompasses three floristic zones: (1) the Mojave Desert, which is a warm dry desert occurring below an elevation of 1,200 meters (4,000 ft); (2) the Great Basin Desert, which is a relatively cooler and wetter desert at elevations above 1500 meters (5,000 ft); and (3) the transition zone, often called the Transition Desert, which extends in a broad east-west corridor between the Mojave and Great Basin deserts at elevations of between the Mojave and Great Basin deserts at elevations of between 1,200 and 1,500 meters (4,000 and 5,000 ft) (DOE, 1986). There are areas of desert woodland (pinyon-juniper) at higher elevations. Even there typical Great Basin shrubs, principally sagebrushes, are a conspicuous component of the vegetation. Although shrubs, or shrubs and small trees, are the dominant forms, herbaceous plants are well represented in the flora and play an important role in supporting animal life (DOE, 1990a).

(U) The flora of the SMTS location is typical of that of the Mid Valley area. It is described as Transitional Desert Association consisting predominantly of widely spaced clumps of low brush, interspersed with sparse growths of grasses and other low plants and scattered Joshua Trees (SNL, 1990b). Vegetative coverage of the soil surface is approximately 20%. Blackbrush (Coleogyne ramosissima) is the predominant plant species. Other plant species identified during a pre-activity survey that was performed at the SMTS location include:

TABLE 3.2-1 (U):
AMBIENT AIR QUALITY STANDARDS
(MICROGRAMS PER CUBIC METER) (U)

Pollutant and Averaging Time	National Ambient Air Quality Standards Primary	Secondary	Nevada Ambient Air Quality Standards
Sulfur Dioxide			
3-Hour[a]	---	1,300	1,300
24-Hour[a]	365	---	365
Annual Arithmetic Mean	80	---	80
Particulate Matter:			
As TSP[b]			
24-Hour[b]	260	150	150
Annual Geometric Mean	75	60	75
As PM_{10}[b]			
24-Hour	150	150	[d]
Annual Arithmetic Mean	50	50	[d]
Nitrogen Dioxide[c]			
Annual Arithmetic Mean	100	100	100
Ozone			
1-Hour[a]	235	235	235
Carbon Monoxide			
1-Hour[a]	40,000	40,000	40,000
8-Hour[a]	10,000	10,000	6,570[e]
Lead			
Quarterly Arithmetic Mean	1.5	1.5	1.5

[a] (U) Short-term national standards (24 hours or less) not to be exceeded more than once per year, at any location.
[b] (U) TSP is in the process of being superseded by PM_{10} (particulates matter with aerodynamic diameter less than 10 microns) as the ambient standard indicator for particulate matter.
[c] (U) Although there are no Nevada or National short-term NO_2 standards, California has adopted a one-hour standard of 470 $\mu g/m^3$.
[d] (U) Nevada has not yet adopted PM_{10} standards, but the standards are expected to be at least as stringent as the Federal Standards.
[e] (U) At elevations above 1,524 m (5,000 ft) MSL. At lower elevations the Nevada eight-hour CO standard is 10,000 $\mu g/m^3$.

Yucca brevifolia (Joshua Tree)
Chrysothamnus teretifolius
Cowania mexicana
Yucca schidigera
Ephedra nevadensis (Mormon Tea)
Coryphantha vivipara
Annual grasses particularly Bromus rubens.

Fauna (U)

(U) The southern Great Basin is occupied by a variety of birds, reptiles, and mammals representing faunal elements from both the Mojave and Great Basin Deserts. Most animals are small, secretive (often nocturnal in habitat), and hence not often seen. Wildlife habitats on the NTS have been modified to a considerable degree by nuclear testing activities and by a few extensive brush fires. Because there is no sporting and only a limited amount of pest control, faunal populations are regulated only by the natural controls imposed by the environment and normal predator/prey relationships. Rodents account for almost half of the known species, and are, in terms of distribution and relative abundance, the most important group of mammals on the NTS. Activity patterns, food habits, population dynamics, life spans, and home ranges are well documented for the small mammals of the area (Jorgensen and Hayward, 1965).

(U) Sixty-six species of birds are recorded as either seasonal or permanent residents in the area. Many other species visit the area briefly during spring and fall migration. There are 27 permanent breeding residents, most of which inhabit sagebrush-pinyon-juniper vegetation, and a number of more widely distributed spring and summer residents. The southern Great Basin is a winter feeding ground for large flocks of migrating passerine birds (sparrows and finches). Several species remain as winter residents because disturbed areas have an abundance of tumbleweed seed, which is an important winter food source. Migratory waterfowl and shore birds frequent the temporary lakes formed by precipitation runoff in Yucca and Frenchman playas (Appendix E).

(U) Reptiles observed in the region include eight species of lizards, one tortoise specie (Gopherus agassizii), and four species of snakes. The side blotched lizard (Uta stansburania) and western whiptails (Cnemidophorus tigris) were the most frequently observed and ubiquitous lizard species. The Mojave desert tortoise (Gopherus agassizii) has been infrequently observed south of Shoshone Mountain and the Mid Valley. Coachwhips (Masticophis flagellum); speckled rattlesnakes (Crotalus mitchelli); gopher snakes (Pituophis melanoleccus); and western shovel-nosed snakes (Chinactis occipitalis) have been infrequently observed (DOE, 1986).

(U) Coleogyne is described as nearly pure strands of blackbrush that occupy large areas in Mid-Valley and the lower slopes of mountains and mesas in the north-central part of the NTS, at elevations of 1,220 to 1,520 meters (4,000 to 5,000 ft). Resident fauna at the proposed SMTS site are those typical of the blackbrush plant communities in Mid-Valley. Evidence of small lizards and rodents living in the area have been found. Transient animals include rabbits, mule deer and coyotes. The birds found here are typical of blackbrush areas.

3.2.1.3.2 Aquatic Ecology (U)

(U) There are no known aquatic resources within the SMTS area.

3.2.1.3.3 Threatened and Endangered Species (U)

(U) Flora: No plant species located on the NTS is currently on the federal threatened and endangered species list.

(U) Guidelines and operating procedures have been developed at the NTS to protect and preserve threatened and endangered plant species in compliance with the Endangered Species Act of 1973. These procedures have been established in the standard operating procedure for the NTS (NTS SOP 5407 - "Preservation of Antiquities, Historical Sites, and Threatened and Endangered Plant Species").

(U) A threatened and endangered species survey was conducted at the proposed SMTS within the NTS and no threatened or endangered or candidate species were found (Appendix F).

(U) Fauna: The desert tortoise, Gopherus agassizii, was officially listed as a threatened species in April 1990 by the U.S. Department of Interior. Tortoise habitats on the NTS are found in the southern third of the NTS, south of areas of nuclear test activities in Yucca Flat, Rainier Mesa, and Pahute Mesa.

(U) Based on a survey conducted by EG&G, no threatened or endangered species, or their habitat, are known to occur at the SMTS site (EG&G, 1988). The SMTS is north of the known range of the threatened desert tortoise. The water supply well (Figure 3.2-5) lies near the northern limit of the estimated range of the desert tortoise at NTS although available survey data are not considered conclusive regarding the existence of tortoises in Mid Valley (EG&G, 1991).

3.2.1.4 Background Radiation (U)

(U) This section provides information on environmental radiation, radiation sources, radiation, and environmental radiation monitoring program.

3.2.1.4.1 Environmental Radiation Sources and Exposure (U)

(U) Environmental radiation consists of natural background radiation from cosmic, terrestrial, and internal body sources. Additional sources of background radiation are medical and dental diagnosis, nuclear weapons test fallout, consumer and industrial products , air travel , brick and stone buildings, and radioactive releases associated with NTS operations.

(U) Environmental background radiation levels from all sources in the general area surrounding the NTS vary considerably depending mainly on elevation and natural radioactivity content of the soil. At the NTS radiological effluents may originate from: (1) tunnels, (2) underground test event sites (at or near surface ground zeros), and (3) facilities where radioactive isotopes are either used, processed, stored, or discharged. All of these types of sites have the potential

or are known to discharge radioactive effluents into the environment (DOE, 1990a). Some radioactivity remains on the surface of NTS from pre-1962 atmospheric testing of weapons, nuclear cratering explosions, nuclear propulsion systems tests, and radioactive wastes generated by other NTS activities.

(U) The extensive off-site environmental surveillance system operated around the NTS by the EPA measured no radiological exposures that could be attributed to NTS operations. Calculation of potential dose to off-site residents, based on the on-site source emission measurements and use of EPA's AIRDOS-PC model, resulted in a maximum calculated dose of 1.5 x 10^{-4} mrem (0.00015 mrem) to a resident of Pahrump, Nevada, 80 kilometers (50 mi) south of the NTS Control Point. Monitoring network data indicated a 1989 dose of 67 mrem from background radiation at Pahrump. The calculated population dose to the 8400 residents living within 80 kilometers of the Control Point was 1.1 x 10^{-3} person-rem (0.0C11 person-rem, or 1.1 x 10^{-5} person sievert) (DOE, 1990a). It is anticipated that the population dose to residents within an 80 km (50 mi) radius of the SMTS would be somewhat less. The number of persons residing within 80 km of the SMTS, located approximately 11 km (7 mi) from the Control Point, has been estimated to be 5,400 (EPA, 1991b).

3.2.1.4.2 Environmental Radiation Monitoring Program (U)

(U) The U.S. Department of Energy (DOE) is responsible for providing radiological safety services on the Nevada Test Site (NTS) and maintaining an environmental surveillance program designed to control, minimize, and document exposures to the NTS working population. The results are reported annually in environmental reports (DOE, 1990a).

(U) The on-site radiological monitoring program is conducted by several organizations. REECo, the operating contractor at the NTS is responsible for environmental surveillance and effluent monitoring. Several other organizations, such as the Lawrence Livermore National Laboratory (LLNL) Los Alamos National Laboratory (LANL), Desert Research Institute (DRI), EPA, and participants in the Basic Environmental Compliance and Monitoring Program also make radiological measurements.

(U) The EPA conducts the off-site radiological monitoring program around the NTS. The Agency's EMSL-LV is responsible for conducting the program. The routine surveillance program includes pathways monitoring that consists of air, water, and milk surveillance networks surrounding the NTS, and a limited animal and vegetable sampling program. In addition, external and internal exposures of off-site populations are assessed using state-of-the-art dosimetry equipment.

(U) Air Monitoring: The on-site environmental surveillance program maintains samplers designed to detect airborne radioactive particles, radioactive gases (including halogens and noble gases), and radioactive hydrogen (^{3}H) as water vapor in the form $^{3}H^{1}HO$ or ^{3}HHO. Air sampling units were located at 52 stations on the NTS to measure radionuclides in the form of particulates and halogens. All placements were chosen primarily to provide monitoring of radioactivity at sites with high worker population density. The results of the on-site monitoring studies are provided in Table 3.2-2 below. Radionuclide concentration guidelines are provided in Table 3.2-3 below for comparative purposes. Ambient gamma monitoring has been conducted at 150 stations within the NTS through the use of thermoluminescent dosimeters (TLDs).

(U) The Air Sampling Network (ASN) is designed to monitor the off-site areas within 350 kilometers of the NTS, with some concentration of stations in the prevailing downwind direction. This continuously-operating network is supplemented by a standby network which covers the contiguous states west of the Mississippi River. During 1989 the ASN consisted of 31 continuously-operating sampling stations and 78 standby stations.

(U) A second part of the EPA off-site air network was the Noble Gas and Tritium Surveillance Network (NGTSN). The sources of these radionuclides include noble gases and tritium emitted from nuclear reactors, reprocessing facilities (non-NTS facilities), and worldwide nuclear testing. Network samplers were typically located in populated areas surrounding the NTS with emphasis on night-time "drainage" winds leading from the test areas. Other samplers were located in communities at some distance from the NTS. In 1989 this network consisted of 20 sampling stations located in the states of Nevada, Utah, and California.

(U) Water Monitoring: On-site water samples were collected at various frequencies from selected potable water consumption points, supply wells, natural springs, open reservoirs, final effluent ponds, and contaminated ponds. The frequency of collection was determined on the basis of a preliminary radiological pathways analysis. All samples were analyzed for gross beta, tritium, and gamma emitting isotopes. Plutonium analyses were performed on a quarterly basis.

(U) As part of EPA's Long Term Hydrological Monitoring Program, surface water and groundwater sampling and analysis have been performed for many years on water sources on and around the NTS. At the sample collection sites, the pH, conductivity , and water temperature were measured when the water sample was collected. Also, after the first time samples were collected from a well, ^{89}Sr, ^{90}Sr, ^{226}Ra, ^{238}Pu, $^{239+240}Pu$, and uranium isotopes were determined by radiochemistry as time permitted.

(U) The samples were collected monthly, when possible, and analyzed by gamma spectrometry as well as for ^{3}H. For a few NTS wells and for all the water sources around the NTS, a sample was collected twice per year at about a six month interval. One of the semi-annual samples was analyzed for ^{3}H by the conventional method, the other by enrichment. The results of the on-site monitoring studies are provided in Table 3.2-2 above. Radionuclide concentration guidelines are provided in Table 3.2-3 above for comparative purposes.

[redacted]

TABLE 3.2-2 (U):
NTS ON-SITE MONITORING RESULTS (U)

Radionuclides in Air (Network Annual Average) (U)

Radionuclide (U)	uCi/ml (U)
$^{239+240}$Pu	< 1×10^{-15}
^{238}Pu	< 1×10^{-17}
^{85}Kr	$23 \times 10^{-12} \pm 5.2 \times 10^{-12}$
^{133}Xe	*
^{3}H	$8.5 \times 10^{-12} \pm 1.5 \times 10^{-11}$
^{40}K	4.3×10^{-14}
^{90}Sr	2.2×10^{-14}

* (U) For the large majority of samples collected during 1989, ^{133}Xe results were below the detection limit.

Radionuclides in Water (Network Annual Average) (U)

Radionuclide (U)	Open Resevoir (U) (uCi/ml)	Supply Well (U) (uCi/mL)	Drinking Water (U) (uCi/mL)
$^{239+240}$Pu	3.0×10^{-11}	2.3×10^{-13}	9.8×10^{-13}
^{238}Pu	-2.4×10^{-10}	-2.9×10^{-12}	-3.0×10^{-12}
^{3}H	1.1×10^{-7}	1.1×10^{-7}	4.5×10^{-8}
^{40}K	6.9×10^{-9}	6.9×10^{-9}	5.8×10^{-9}
^{226}Ra			3.0×10^{-9}**

** (U) Maximum value

[redacted]

TABLE 3.2-3 (U):
RADIONUCLIDE CONCENTRATION GUIDES
FOR AIR AND WATER (U)

	uCi/ml			
Radionuclide	DAC (air)[a]	DCG (air)[b]	DCG (water)	MCL (water)[c]
^{3}H	2×10^{-5}	1×10^{-7}	2×10^{-3}	2×10^{-5}
^{40}K	2×10^{-7}	9×10^{-10}	7×10^{-6}	-
^{85}Kr (ns)	1×10^{-4}	3×10^{-6}	-	-
^{90}Sr	8×10^{-9}	9×10^{-12}	1×10^{-6}	8×10^{-9}
^{133}Xe (ns)	1×10^{-4}	5×10^{-7}	-	-
^{226}Ra	3×10^{-10}	1×10^{-12}	1×10^{-7}	5×10^{-9}
^{238}Pu	3×10^{-12}	3×10^{-14}	4×10^{-8}	-
$^{239+240}Pu$	2×10^{-12}	2×10^{-14}	3×10^{-8}	-

(ns) = nonstochastic value (U)

(a) (U) DAC - The Derived Air Concentration used for limiting radiation exposures through inhalation of radionuclides by workers. The values are based on either a stochastic (committed effective dose equivalent) dose of 5 rem or a nonstochastic (organ) dose of 50 rem, whichever is more limiting. In the table, the value shown is a stochastic limit unless followed by (ns).

(b) (U) DCG - Derived Concentration Guides are reference values for conducting radiological environmental protection programs at operational DOE facilities and sites. The DCG values for internal exposure shown are based on a committed effective dose equivalent of 100 mrem for the radionuclide taken into the body by ingestion or inhalation during one year.

(c) (U) MCL - The Maximum Contaminant Level is the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system. MCL values are reported in the EPA National Primary Drinking Water Standards (40 CFR 141). The values listed in the table are based on 4 mrem committed effective dose equivalent for the radionuclide taken into the body by ingestion of water during one year.

(U) Milk Surveillance Network: In 1989 the Milk Surveillance Network (MSN) consisted of 27 locations within the 300 kilometers of the NTS from which samples were scheduled for collection every month. In addition, all major milksheds west of the Mississippi River, represented by 106 locations in 1989, were sampled on an annual basis as part of the Standby Milk Surveillance Network (SMSN). All samples were analyzed by high resolution gamma spectroscopy to detect gamma-emitting radionuclides. One sample per quarter for each location in the SMSN were subjected to radiochemical analytical evaluations. These samples were analyzed for ^{3}H by liquid scintillation counting, and for ^{89}Sr and ^{90}Sr by anion exchange method.

(U) Although all samples collected for the MSN and SMSN were analyzed for gamma-emitting radionuclides, only naturally occurring potassium-40 (^{40}K)[1] was detected for either network in any sample. Tritium was measured above the minimum detectable concentration in two samples from locations on the MSN - Inyoken, Ca and Currant, Nev.

(U) Biomonitoring: Samples of muscle, lung, liver, kidney, blood, and bone were collected from cattle purchased from private herds that graze adjacent to the NTS. Soft tissues were analyzed for gamma-emitting radionuclides. Bone and liver were analyzed for strontium and plutonium, and blood was analyzed for ^{3}H. Each November and December, bone and kidney samples from desert bighorn sheep killed and donated by licensed hunters in Southern Nevada have been analyzed for strontium, plutonium, and tritium. These kinds of samples have been collected and analyzed for up to 32 years to determine long-term trends (Appendix G).

(U) External Gamma Exposure Monitoring: The EPA's off site TLD network was designed primarily to measure total ambient gamma exposures at fixed locations. A secondary function of the network was the measurement of exposures from past nuclear tests to off-site residents living within estimated fallout zones. Measurement of exposures to specific individuals involved the multiple variables associated with any personnel monitoring program. Measuring environmental ambient gamma exposures in fixed locations provided a reproducible index which could then be easily correlated to the maximum exposure an individual would have received were the person continuously present at that location. Monitoring of individuals made possible an estimate of individual exposures and helped to confirm the validity of correlating fixed-site ambient gamma measurements to projected individual exposures. During 1989 a total of 135 off-site stations were monitored to determine background ambient gamma radiation levels.

(U) The mean annual exposure at the fixed environmental stations was 66 $\pm$ 32 mrems. Ambient gamma exposures measured by TLDs at fixed environmental stations as part of this network were within the range of exposures anticipated throughout the U.S. due to "natural background".

(U) During 1989 a total of 65 individuals living in areas surrounding the NTS were provided with personnel dosimeters. The TLDs were used to monitor beta, gamma, neutron, and low- and high-energy x-radiations. The TLDs used to monitor fixed reference background locations were designed to be sensitive only to gamma and high-energy x-radiations. Because personnel dosimeters were cross-referenced to associated fixed reference background TLDs, all personnel

[1](U) ^{40}K is a naturally occuring radioactive isotope of potassium with a half-life of 1.3 x 10^{9} years.

[redacted]

exposure measurements present were presumed to be gamma or high-energy x-radiation. Exposures of this type were numerically equivalent to the absorbed dose.

(U) Of 65 offsite residents monitored with personal TLDs, 60 showed zero detectable exposure above that measured at the associated reference background location. The apparent individual exposures were slightly greater than the associated reference background. These ranged from 16 to 48 mrem absorbed dose equivalent for the year. Each of these represented total exposures obtained from several dosimeters worn during the year. Apparent exposures to an individual dosimeter of less than three times the associated reference background are considered to be within the range of normal variation for the TLD system. Therefore, none of the apparent net individual exposures are considered to represent an abnormal occurrence.

(U) Population Radionuclide Uptake Monitoring: The EPA whole-body counting facility has been maintained at the EMSL-LV since 1966. The facility is equipped to determine the identity and quantity of gamma-emitting radionuclides which might have been inhaled or ingested by off-site residents and others exposed to 1989 NTS radiation releases. Routine "counting" of radionuclides in a person consisted of a 2000 second count with a sensitive radiation detector placed next to a person reclining in one of two shielded rooms. The off-site Human Surveillance Program was initiated in December 1970 to determine the levels of radionuclides in some of the families residing in communities and ranches surrounding the NTS.

(U) During 1989 EPA obtained a total of 904 gamma spectra from whole-body counting of 221 individuals. In general the spectra were representative of normal background and showed only naturally occurring ^{40}K.

[redacted]

[redacted]

3.2.2 Idaho National Engineering Laboratory (U)

(U) The following description of the U.S. Department of Energy's (DOE) Idaho National Engineering Laboratories (INEL) is based primarily on the INEL Environmental Characterization Report, the Special Isotope Separation Project Final Environmental Impact Statement (EIS) and the New Production Reactor Capacity Draft Environmental Impact Statement and a reconnaissance carried out by DMSS staff members.

<u>Site Location and Background</u> (U)

(U) Idaho National Engineering Laboratories (INEL) of the Department of Energy (DOE) was established by the Federal Government in 1949 to conduct research and further the development of nuclear reactors and related equipment. Major DOE programs at INEL include test irradiation services, uranium recovery from highly enriched spent fuels, calcination of liquid radioactive waste solutions, light-water-cooled reactor safety testing and research, operation of research reactors, environmental restoration, and storage and surveillance of transuranic wastes (DOE, 1991a). More than 50 reactors have been built at the INEL, of which 14 are still in active status. Major facilities at the INEL are operated by Argonne National Laboratory-West, EG&G Idaho, Rockwell-INEL, Westinghouse Electric Corporation, and Westinghouse Idaho Nuclear Company. Additional facilities proposed for INEL include the New Production Reactor (NPR) and the Nuclear Weapons Complex Reconfiguration Site (NWCRS).

(U) INEL, located in the southeastern portion of Idaho (Figure 3.2-8), encompasses approximately 230,000 hectares (580,000 acres) extending approximately 63 kilometers (39 miles) from north to south and about 58 kilometers (36 miles) from east to west at the broadest southern part. Regionally, the site is situated on the Upper Snake River Plain and is located about equal distant from Salt Lake city, Utah and Boise, Idaho. Public access to the INEL is restricted to a few public highways that are patrolled by on-site security personnel.

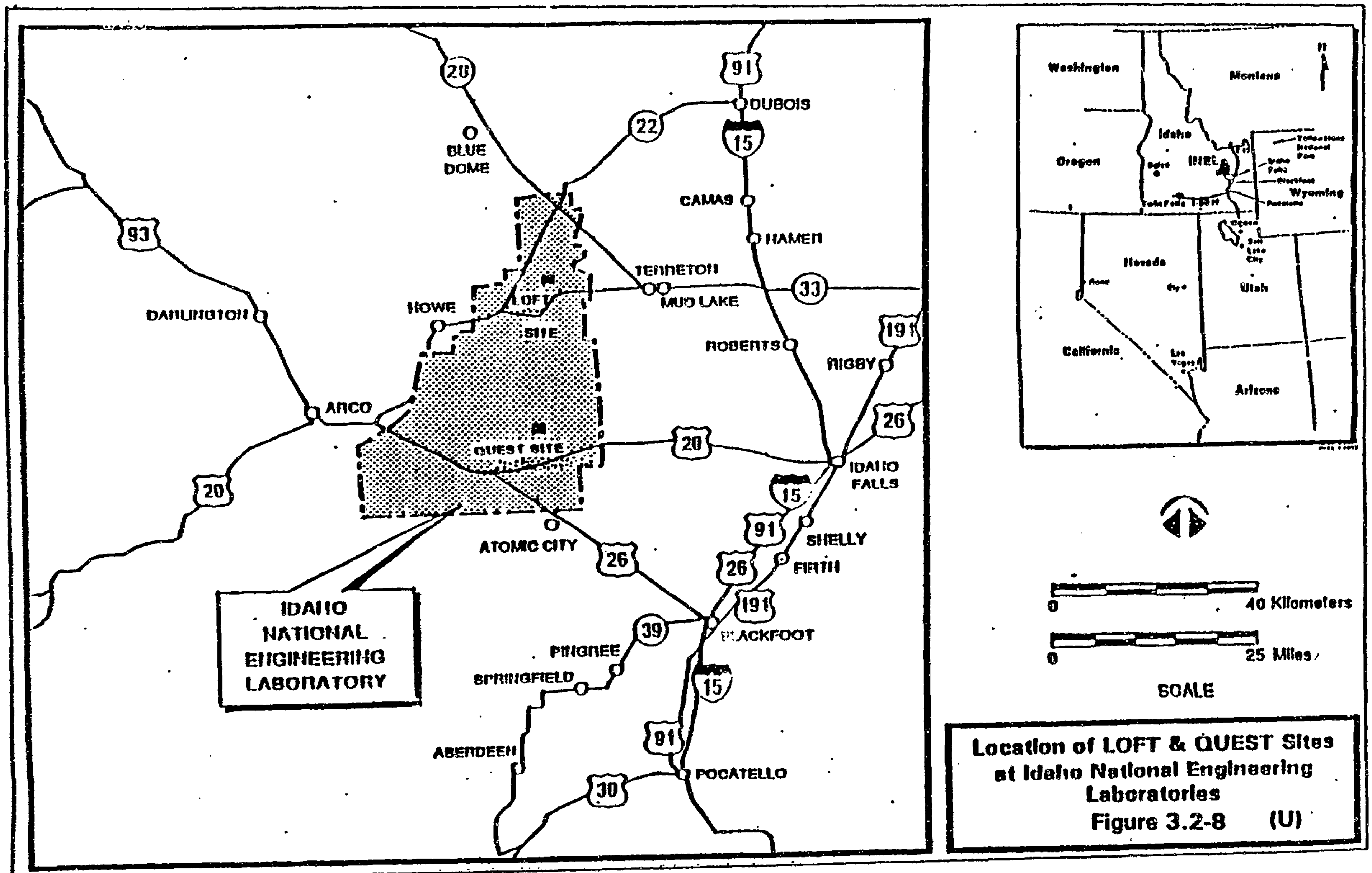
(U) The proposed QUEST site is located in the central portion of INEL. This site is currently undeveloped and is situated approximately 8 km (5 mi) from the nearest operating facility.

(U) The LOFT site is part of the Test Area North (TAN) complex located in the northern portion of INEL. TAN was originally established in the 1950s to support the U.S. Air Force and Atomic Energy Commission Aircraft Nuclear Propulsion Program. The program was terminated before a nuclear powered aircraft could be built. Facilities at TAN include an Initial Engine Test Facility, a Technical Support Facility, a Water Reactor Research Facility and the Containment Test Facility (CTF) (CTF was previously the Loss-of-Fluid Test Facility or LOFT.) A four-rail railroad track connects the Initial Engine Test Facility and LOFT areas to the Technical Support Facility.

(U) The CTF area is located at the west end of TAN. The area includes the LOFT Containment and Service Building (reactor facility), an aircraft hanger, the LOFT Reactor Control and Equipment Building and numerous support facilities. A specially designed railroad flatcar is located inside the domed containment vessel to transport mobile reactor assemblies into and out

[redacted]

[redacted]



Location of LOFT & QUEST Sites at Idaho National Engineering Laboratories
Figure 3.2-8 (U)

[redacted]

of the containment vessel. Systems for operating and monitoring the reactor are located inside structures immediately adjacent to the containment vessel.

3.2.2.1 Socioeconomics (U)

(U) This section summarizes the population distribution, economy and employment of the INEL.

3.2.2.1.1 Population and Economy (U)

(U) The supporting region for the INEL is the six-county surrounding area (Bannock, Butte, Jefferson, Bonneville, Bingham, and Madison). The largest population centers nearest the INEL are to southeast and east along the Snake River and Interstate Highway 15. The largest communities in close proximity to the boundaries of the INEL include Idaho Falls, Blackfoot, and Arco (Figure 3.2-9). The total population within an 80 km (50 mi) radius of the NWCRS increased 9% from 118,260 in 1980 to 127,494 in 1990. The 1990 population density within 80 km (50 mi) of the NWCRS control point is approximately 7.1 persons per square kilometer.

(U) Agriculture is the major economic activity in the six-county area surrounding the INEL and contained about 4,700 farms in 1987 (DOE, 1991a). Approximately 38 percent of the farmland is used to produce irrigated and non-irrigated cultivated crops and about 48 percent is used for pasture or grazing. Major farm commodities include grains, feeds (hay and silage), potatoes, vegetables, and livestock. In 1988, receipts from the sale of field crops totaled $373 million, and livestock sales were $157 million. Total agricultural sales in Idaho in 1988 were about $1 billion in each category.

(U) INEL is the largest single employer in Idaho, accounting for more than $318 million in wages during 1987. Employment at INEL currently totals about 11,000 or about 2.6% of total state employment. About 320 persons are DOE employees, and the rest are employed by private contractors.

(U) Other major sources of employment and income in the INEL region include services, government, retail trade, and manufacturing. The three industries with the largest employment in 1980 were services (29 percent), retail trade (15 percent), and manufacturing (11 percent). In the six-county area, these three industries accounted for 55% of all employment. The nonagricultural industries with the largest payrolls in 1984 came from the services, government, and manufacturing industries.

3.2.2.1.2 Land Use and Infrastructure (U)

Land Use (U)

(U) Land use in the INEL area is severely restricted by the dry climate and shallow bedrock (Figure 3.2-10). Arable land with moderate irrigation limitation (gravity irrigation) is present on both sides of the Big Lost River and in the remains of the lake bed of prehistoric Lake Terreton (between Mud Lake and Howe). The remainder of the INEL, approximately 65% of the surface area, has a low sub-surface water-holding capacity, is rocky or covered with basalt,

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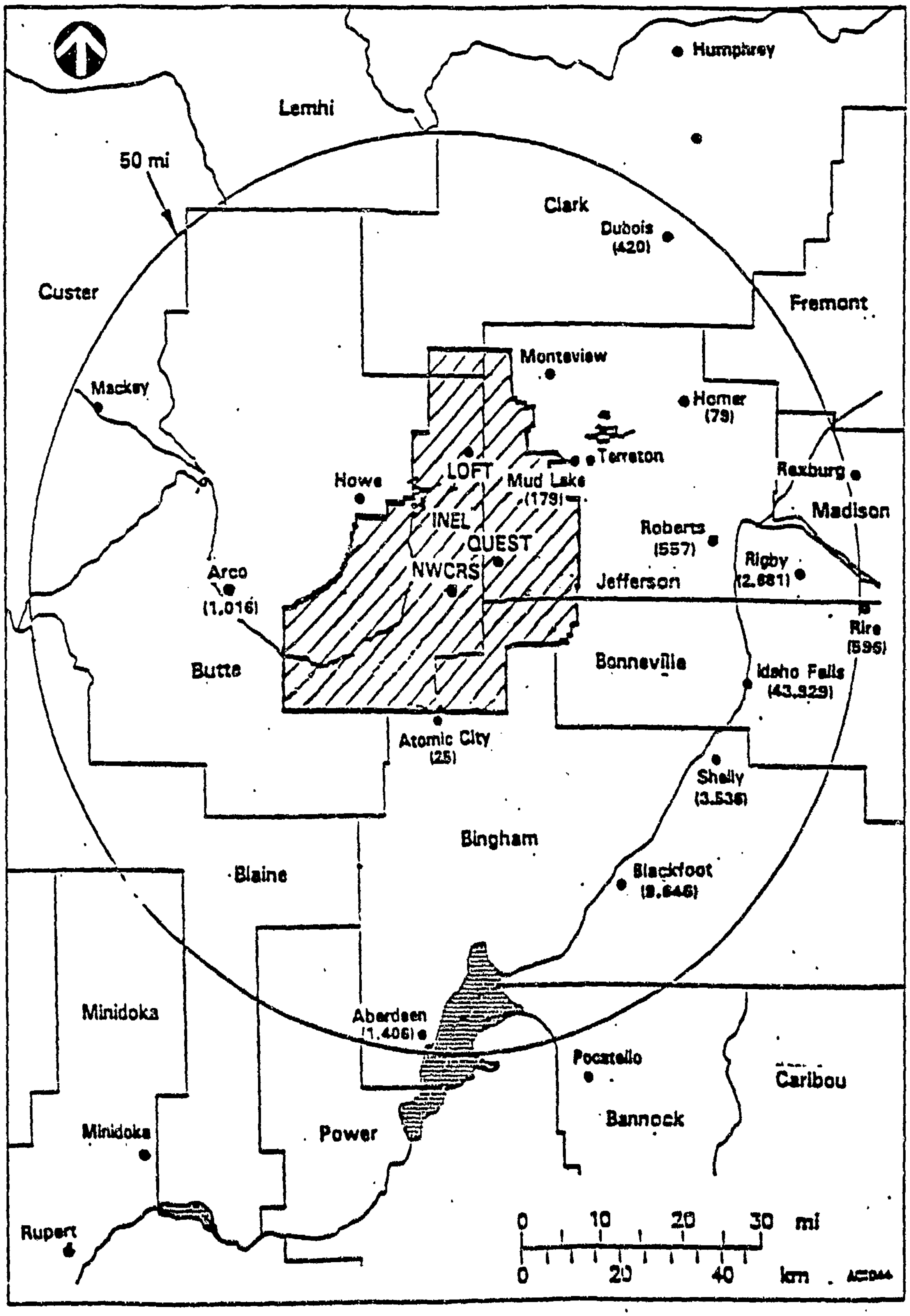

Figure 3.2-9 (U)

Population Distribution Within 80 km (50 mi) Radius of the [redacted]

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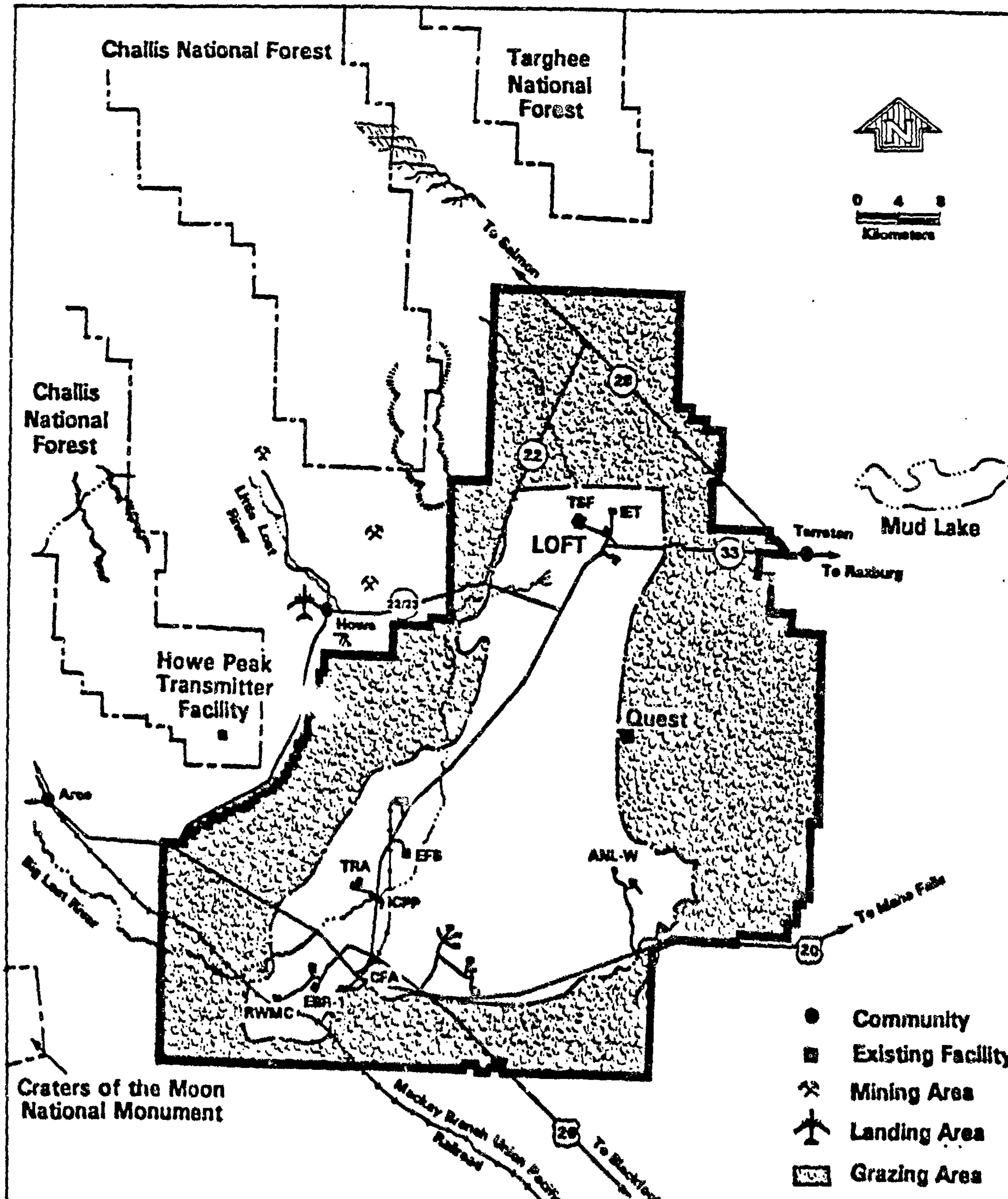

Figure 3.2-10 (U)

Land Uses at INEL and the Surrounding Areas

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or is classified as having moderate-to-severe limitations for agricultural irrigation. Approximately 330,000 acres are open to controlled grazing by cattle or sheep as allocated by DOE and the Department of Interior (DOI). Grazing is prohibited within 3 km (2 mi) of any nuclear facility, and no dairy cows are allowed.

(U) Agriculture: The area immediately surrounding the INEL is either desert or agricultural land. Most of the nearby land used for farming is concentrated to the northeast along the lower course of the Big and Little Lost Rivers. Approximately 95 percent of INEL has been withdrawn from the public domain and is controlled by DOE. The remaining 5 percent includes public highways crossing the site, the Naval Reactor Facility (Department of Defense), and the Experimental Breeder Reactor, Number 1 (EBR-1) historic landmark. A series of public land orders, dating back to 1946, has established the present uses of the site.

(U) Water Resources: Most rural agriculture in the area has developed because of storage and diversion projects on the Snake River, Big Lost River, Birch Creek, Camos Creek, and Beaver Creek. In addition, wells in Bingham, Butte, and Jefferson Counties provide water for cattle & sheep grazing operations. With very few exceptions, the source of water for domestic uses is ground water. The Big Lost River is the most significant element affecting surface water hydrology, and besides irrigation diversions, the Mackay Dam, 48 km (30 mi) above Arco, and the INEL flood diversion system, in the southwest corner of INEL have affects on the river.

(U) Recreation: The three most prominent recreation areas or attractions in the INEL area include Craters of the Moon National Monument to the southwest, and the resort areas of Ketchum and Sun Valley, which are approximately 96 km (59.5 mi) west of INEL.

(U) Industry: The principal industry within the INEL region is agriculture. Other major industries include food processing, tourism, and mining. The economy is enhanced by INEL activities.

Infrastructure (U)

(U) This section provides data in the following areas: education, health services, public safety, public and municipal services, and transportation.

(U) Education: In the six counties there are 16 public school districts, and five vocational schools, colleges, and universities. Based on demographic studies, Bannock, Bingham, and Bonneville Counties accommodate the majority of the primary and secondary school students from families involved in INEL-related activities.

(U) Health Services: The health services in the INEL area are adequate and are continuously being improved; there are seven general medical and surgical hospitals in the six county area. Health services in the area include nursing homes, intermediate health care facilities, and emergency medical care. Emergency medical facilities are adequate and are expanding.

(U) Public Safety: The southeastern portion of Idaho has an excellent public safety record and is below the national average in all major categories of crime. The number of police in Idaho is near the national average, but local coverage is greater. Public safety is further assured by adequate fire department coverage in all locales bounding the INEL.

(U) Public and Municipal Services: These services in southeast Idaho are adequate to serve an additional 4,000-5,000 people. Municipal services include power, water, sewage, and garbage disposal. Drinking water is supplied through public water supply systems in each of the larger communities; all community systems use ground water except for Pocatello which obtains 20 percent from the Snake River. Sewage services are provided in the communities by the local governments. All systems have excess capacity or have plans to expand to meet future demand. Public Services also include recreation areas, library facilities, etc.

(U) Transportation: INEL and its associated facilities are served by an extensive transportation network capable or moving thousands of persons and tons of freight everyday. Commercial service is available from airlines, regional and interstate trucking firms, bus lines, and railroads. Since there are more than 20 facilities spread over a 230,000 hectares (570,000 acres) area inside a 242-km (151 mi) boundary, INEL relies heavily on its own transportation system and those of commercial organizations to maintain the supply of goods and services.

3.2.2.1.3 Noise (U)

(U) The major noise sources within INEL include various facilities equipment and machines (e.g. cooling towers, transformers, engines, pumps, steam vents, construction and materials handling equipment, and vehicles). At the INEL boundary, away from most of these industrial facilities, noise from these sources would be barely distinguishable from background noise levels. Since the airspace is controlled, only limited overhead aircraft activity is available to provide an impact to the existing noise levels. The acoustic environment along the INEL boundary is assumed to be that of a rural location with typical residual noise levels of 30-35 dBA (DOE, 1991a).

(U) The major sources of noise at the QUEST site are natural physical phenomena such as wind, rain, and the activities of wildlife. Based on the average annual wind speed of approximately 3 m/s (7 mph), the location of the proposed QUEST Site is considered windy with a desert noise level of approximately 38 dBA (DOE, 1990a). The noise level at the LOFT facility would be relatively similar because the facility is currently not used.

3.2.2.1.4 Historic and Archaeological Resources (U)

(U) The earliest known occupants of southeastern Idaho were big game hunters who hunted now-extinct mammals (e.g. mammoth) approximately 12,000 to 7,500 years before present. Winter camps were reportedly scattered along major river drainages, while populations dispersed in the remaining seasons probably moving across what is now the INEL area as they exploited a wide selection of locally available food sources (DOE, 1991a).

(U) Places of historic significance that are listed on the National Register of Historic Places are primarily concentrated in the cities and towns surrounding the INEL. The INEL protects cultural resources as required by the Antiquities Act of 1906, the Historic Sites Act of 1936, and the National Historic Preservation Act of 1966. The objective of these procedures is to avoid loss of material that may have archeological or historic value. To date, approximately 3 percent [greater than 8,100 hectares (20,000 acres)] of the total land area of the INEL has been surveyed for cultural resources.

(U) The QUEST Site contains scattered flakes and chips, mainly of obsidian but including milky quartz at the surface of the higher points of the ridge. All observed artifacts appeared to be debitage flakes, although some may have utilized edges. No projectile points or other tools or campsites were observed; because of the topographic prominence of the site, additional artifacts may be expected.

(U) At LOFT, the extensive ground disturbance and earthwork activities during construction has destroyed, removed or buried any archeological sites that may have existed in that area. The terrain setting at LOFT, however, does not suggest the likelihood of any permanent campsites in the area.

(U) All INEL construction and operation activities would be preceded by a cultural resources survey of the affected area. Consultation with the State Historic Preservation Office (SHPO) would take place if cultural resources are located.

3.2.2.1.5 Safety (U)

(U) The Department of Energy policy requires establishment of radiation protection standards commonly applicable to all DOE personnel, DOE contractors, and other INEL users. This policy further requires that all test site operations be conducted in a manner to assure that exposure of individuals, both on-site and off-site populations, to ionizing radiation is limited to the lowest levels technically and economically achievable. The requirements of DOE Orders and 10 CFR 20 are applicable. The DOE policy is to keep occupational exposures of personnel as low as reasonably achievable (ALARA).

(U) Currently the maximum permissible exposure standards for occupational workers are set forth in DOE Order 5480.11, Paragraph 9, "Requirements for Radiation Protection." This policy establishes two categories within the work force: monitored workers subject to occupational exposure standards and general site workers administratively controlled to 1/10 the occupational exposure standards. INEL users are responsible for assuring that the system of personnel dosimetry is properly used by their staff.

Safety Analyses Reports (U)

(U) Individual safety analysis reports (SAR's) will be prepared for each program test series that is conducted at INEL. They will conform to the format of USNRC Regulatory Guide 1.70 (Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants). The two step reporting format will be employed which will result in a final SAR prior to operating the

[redacted]

facility. All SAR's will be reviewed by INEL's installation safety review process similar to that used by the existing reactor safety review system, and approved by the appropriate Deputy Secretariat at DOE Headquarters (Appendix B).

3.2.2.1.6 Waste (U)

(U) All waste management activities at INEL comply with applicable Federal, state, and local laws and regulations, as well as DOE requirements. Existing waste handling facilities at INEL are located at the Idaho Chemical Processing Plant, the Radioactive Waste Management Complex, and the Waste Reduction Operations Complex. Located at the Central Facilities Area are a Radioactive Mixed Waste Storage Facility, a Hazardous Waste Shipping Facility, and a sanitary landfill.

(U) TRU waste is packaged at the individual facilities that generate this waste and then is kept in retrievable storage at the Transuranic (waste) storage area in the Radioactive Waste Management Complex. The Transuranic Storage Area consists of asphalt storage pads for contact-handled TRU waste. Each pad can store 37,000 m^3 (1.3 million ft^3) of waste. The pads are constructed as required. Sufficient room exists inside the current Transuranic Storage Area boundaries for 16 waste storage pads with the potential storage capacity of 595,000 m^3 (21 million ft^3). As of 1988, 64,000 m^3 (2.3 million ft^3) of TRU waste was stored at this facility. The TRU waste storage capacity is adequate to store INEL baseline projected waste volumes until shipment to the Waste Isolation Pilot Plant (WIPP).

(U) All TRU waste is processed through the Stored Waste Examination Pilot Plant prior to off-site disposal at WIPP. At this plant, each TRU waste container is examined in a three step process to ensure that the container meets the certification criteria for waste sent to WIPP. The facility has approximately 1,040 m^3 (37,000 ft^3) of on-site storage space.

(U) The liquid LLW condensate from the Process Equipment Waste Evaporator [up to 15,000 m^3/yr (530,000 ft^3/yr)] is combined with the 1.4-2.8 million m^3/yr (49-99 million ft^3) of nonradioactive waste water from the Idaho Chemical Processing Plant before being discharged to percolation ponds. The use of percolation ponds is scheduled to cease by approximately the year 2000. Evaporator condensate would then be processed at the proposed Liquid Effluent Treatment and Disposal Facility, which will recycle the acidic stream back to chemical process activities at the Idaho Chemical Processing Plant.

(U) Solid LLW is disposed of in an active portion of the fenced Subsurface Disposal Area located in the western part of the Radioactive Waste Management Complex. The Subsurface Disposal area contains pits, trenches, and vaults excavated into basalt. The total volume of waste disposed of in the Subsurface Disposal Area is about 105,000 m^3 (3.7 million ft^3); about 2,900 m^3 (100,000 ft^3) of solid LLW is buried annually.

(U) Mixed wastes are stored at the Radioactive Mixed Waste Storage Facility. As of 1988, 37 m^3 (1,300 ft^3) (of mixed waste had been stored at that facility whose total capacity is 77 m^3 (2,700 ft^3). The current rate of mixed waste generation is 12 m^3/yr (39 ft^3/yr). In the future INEL will treat mixed waste at the Waste Experimental Reduction Facility.

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(U) More than 30 facilities at INEL generate RCRA-regulated hazardous waste. Hazardous waste is temporarily stored at the Hazardous Waste Shipping Facility located in the Central Facilities Area. This facility currently handles 180 m³/yr (590 ft³/yr) of hazardous waste prior to regular off-site shipment for final disposal at licensed RCRA facilities.

(U) Nonradioactive nonhazardous solid waste is disposed of in the Central Facilities Area landfill, which is permitted by the State of Idaho. In 1987, a total of 36,500 m³ (1.3 million ft³) of solid waste was disposed of in INEL sanitary landfills. Nonradioactive, nonhazardous liquid effluent streams are discharged into percolation ponds, evaporation ponds, or sewage treatment facilities, depending on the nature and the source of the waste.

3.2.2.2 Physical Environment (U)

(U) This section summarizes the topography, geology, seismic and volcanic activity, hydrology, and meteorology and climatology of the INEL.

3.2.2.2.1 Topography (U)

(U) INEL lies in the Snake River Plain of southern Idaho adjacent to the southern foothills of the Lemhi, Lost River and Beaverhead Mountain ranges. The surface area of the INEL is relatively flat, with predominant relief manifested either as volcanic buttes jutting up out of the desert floor or as unevenly surfaced basalt flows and/or flow vents and fissures. Elevations on the INEL range from 1,585 meters (5,200 feet) in the northeast to 1,450 meters (4750 feet) in the southwest, with the average being 1,525 meters (5,000 feet).

(U) The proposed QUEST site is on a lava ridge that stands 15 to 30 meters (50-100 ft) above the adjacent plains to the north. The site is at an elevation of approximately 1524 meters (5000 feet) and overlooks much of the northern half of INEL.

(U) The LOFT facility is located near the western margin of the Birch Creek playa, a very smooth surfaced ephemeral lake bed that has an elevation of about 1592 meters (4775 feet) at its lowest point. During construction, the site elevation was raised by fill pads to about 1,600 meters (4,790 feet).

3.2.2.2.2 Geology (U)

(U) The INEL is located on the Eastern Snake River Plain, a physiographic depression extending from the Idaho-Oregon border on the west to the Island Park-Yellowstone Volcanic Plateau on the east. The eastern part of the plain is bordered on the northwest and southeast by the Basin and Range Province. Volcanic rocks of the plain include caldera rhyolites overlain by basaltic lava flows and pyroclastic rocks. These often occur interbedded with alluvial, lacustrine, and eolian sediments. The basalt deposits and interbedded sediments thicken from northeast to southwest along the axis of the Eastern Snake River Plain.

(U) Adjacent basin and Range structural features are composed of displaced Precambrian and Paleozoic sedimentary rocks that were folded and faulted during the Early Cretaceous as they were transported eastward on gently dipping thrust faults. Subsequent Cenozoic tectonism produced the modern basins and ranges by northeast-southwest extension on the normal faults bounding one or both flanks of the ranges. These faults cut or merge at depth with the earlier formed thrust faults.

(U) The basalt of the Eastern Snake River Plain, upon which the INEL is located, contain several northwest-southeast-trending rift zones that may have formed by extension of the Basin and Range tectonism into the area. These rift zones appear to be the main centers of basaltic eruptive activity. Normal faults, oriented parallel to the boundary of the plain, are exposed in places and show no evidence of recent activity. Geophysical investigations of the subsurface suggest that a fault may be present along the edge of the plain near Arco.

(U) The QUEST site is underlain by thick lava flows consisting chiefly of olivine basalt, a dense dark colored volcanic rock (Figure 3.2-11). Overall thickness of the basalt flows may exceed 450 meters (1,500 feet). Individual basalt layers commonly contain vesicles, fractures, joints, and other openings. The ridge on which the site is located marks the forward margin of a single basalt flow. The basalt is commonly extensively fractured, but little of the rock is sufficiently loose to be excavated without blasting. The basalt is expected to provide satisfactory natural foundations for test facility structures although lava tubes and other voids may require filling prior to construction. The basalt is not suitable for crushing for concrete aggregate.

(U) Surficial soils are generally lacking and the fractured lava is exposed at the surface in most places. On the gentler slopes, the basalt is covered by a thin veneer of wind-blown silt. There are no local sources of sand and gravel for construction uses.

(U) Test Area North, the area that includes the LOFT facility, is underlain mostly by unconsolidated lake bed deposits ranging in age from Pleistocene to Recent (Figure 3.2-12). These deposits consist mainly of sandy and clayey silts. Remnants of ancient bars, spits, and beaches that form low ridges in the TAN consist mainly of sand; the largest such ridge forms a natural north-south trending embankment through the Technical Service Facility. Alluvial deposits flanking Birch Creek in the north consist of gravel, sand, and silt that provide the best source of sand and gravel for construction use in the area. Basaltic bedrock underlies the facility at depths of about 10 meters (30 ft). The unconsolidated lake-bed deposits provide suitable natural foundations for light structures, but heavy structures must be supported on bedrock.

3.2.2.2.3 Seismic and Volcanic Activity (U)

(U) The Intermountain Seismic Belt (ISB) and the Idaho Seismic Zone (ISZ) are the two major areas of seismic activity near the Eastern Snake River Plain. Although large-magnitude earthquakes do not originate beneath the INEL, large earthquakes do occur in the adjacent seismic belts (DOE, 1984c). The largest reported earthquake event in the ISZ occurred along the western flank of Borah Peak (Lost River Range) approximately 64 kilometers (40 mi)

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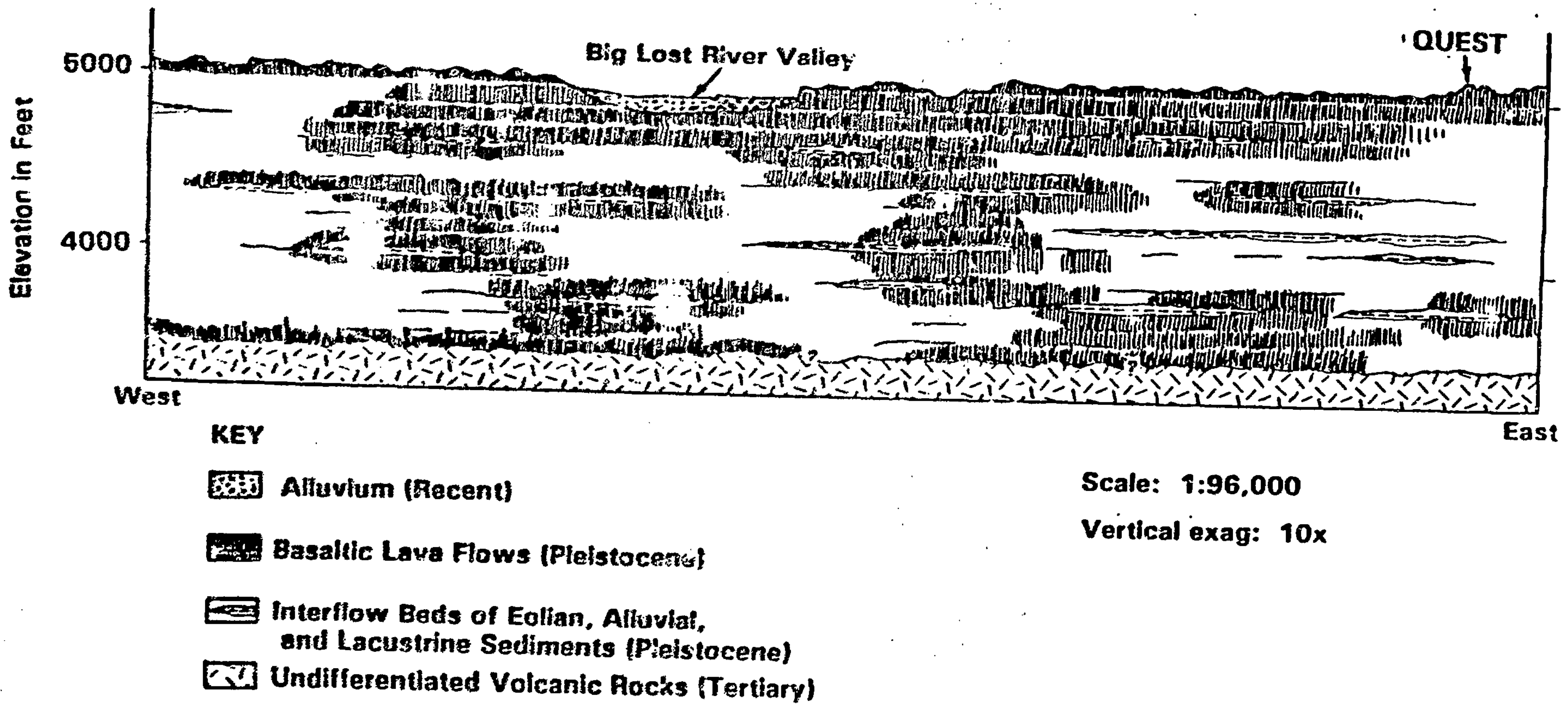

Figure 3.2-11 (U)

Schematic geologic cross section through QUEST site (U)
(from Nace, 1975)

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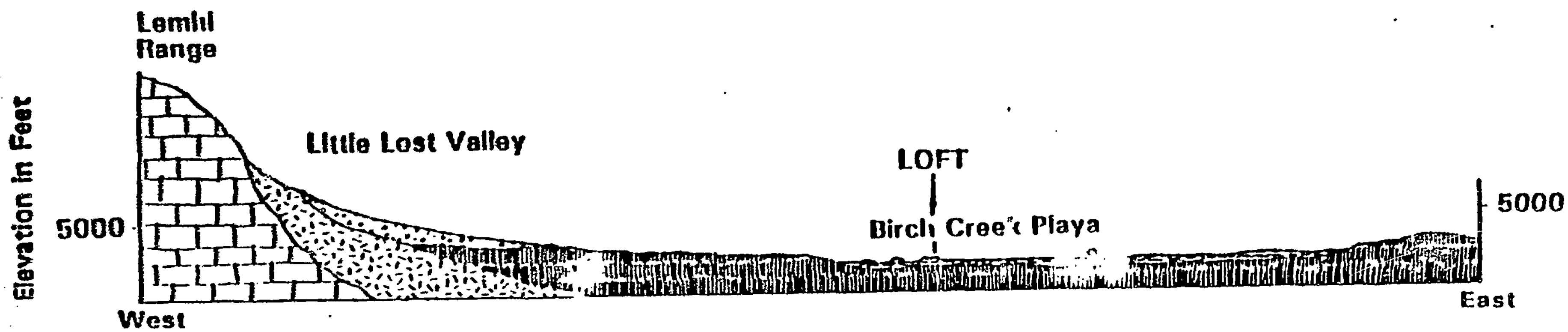
Lemhi



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KEY

Sandy Ridges (Holocene)

Sandy & Clayey Silts (Holocene)

Alluvial Fan Deposits (Holocene)

Basalt Lava Flows (Holocene & Pleistocene)

Undifferentiated Vocanic Rocks (Tertiary)

Limestones (Carboniferous)

Figure 3.2-12 (U)

Schematic geologic cross section through LOFT site (U)
(from Nace, 1975)

[redacted]

northwest of Arco. This earthquake occurred on October 28, 1983, and had a Richter magnitude of 7.3. Although the shock was felt, no structural or safety-related damage occurred at the INEL.

(U) Five earthquakes have been centered within the ESRP since 1971, although none has exceeded a Richter scale magnitude of 1. The only earthquake to have its epicenter within the INEL was a 0.7-magnitude event centered 6 to 8 kilometers (4-5 mi) east of the NRF. No damage from these earthquakes was reported (DOE, 1984c).

(U) The likelihood of a sizable earthquake occurring in the vicinity of the INEL in the foreseeable future is extremely slight because of the following factors. The Snake River Plain and the Basin and Range Province within about 40 kilometers (25 mi) of it are notably aseismic; possible Basin and Range structures do not extend into the ESRP and the Plain shows little evidence of Quaternary faulting except for rift zones associated with basaltic volcanism. Thus it appears that the ESRP responds very differently to the regional tectonism than does the adjacent Basin and Range Province. A boundary fault has been postulated along the northwestern margin of the ESRP but no evidence of any movement over the past 6.5 million years has been observed.

Volcanic Activity (U)

(U) The Eastern Snake River Plain has been subjected to two major stages of volcanic activity over the past 15 million years. Massive deposits of ash-flow tuffs at depth reflect an earlier stage of explosive volcanism from several major eruptive centers within the plain. Over geologic time, the centers of explosive volcanism have migrated progressively to the northeast and are now located in the Yellowstone Plateau nearly 200 kilometers (125 miles) away. Later stages of non-explosive volcanism, beginning about 4 million years ago and continuing to as recently as 2,000 years ago, produced a thick series of many overlapping basaltic lava flows that issued from many local vents and small craters. The basaltic volcanism is postulated to have originated in several northwest-southeast trending rift zones (Figure 3.2-13). The lava flow on which the QUEST site is located originated from small vents to the southeast several hundred thousand years ago. The LOFT site is located between two volcanic rift zones and is underlain by basaltic flows. There are two prominent inactive volcanic craters within 10 km (6 mi) of LOFT.

3.2.2.2.4 Water Resources (U)

(U) Surface Water: There are no permanent surface water features at the INEL. The surface-water hydrology of the INEL is dominated by the Pioneer Basin, a closed drainage basin that receives water from Big Lost River, Little Lost River, and Birch Creek. These rivers are supplied by mountain watersheds located to the north and northwest (Figure 3.2-14).

(U) The Big Lost River is the major river on the INEL. This river flows onto the INEL site across the southwest boundary, curves to the northeast, and terminates at the Big Lost River playas (sinks). The average yearly discharge for the Big Lost River is 8.25 cubic meters per second (290 ft^3 per second) as measured 48 km (30 mi) northwest of Arco, Idaho. The major

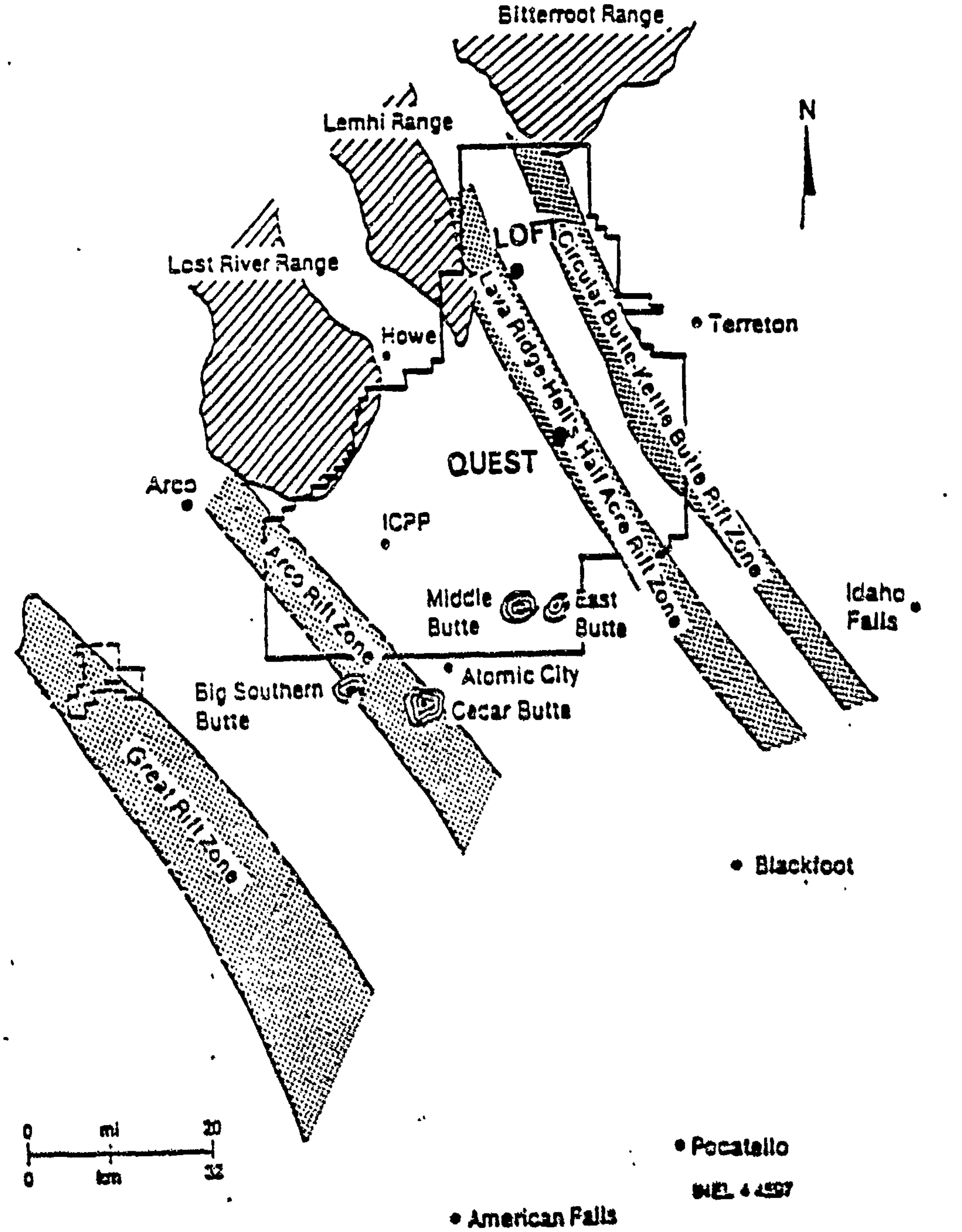

Figure 3.2-13 (U)

Volcanic Structures Near INEL (U)

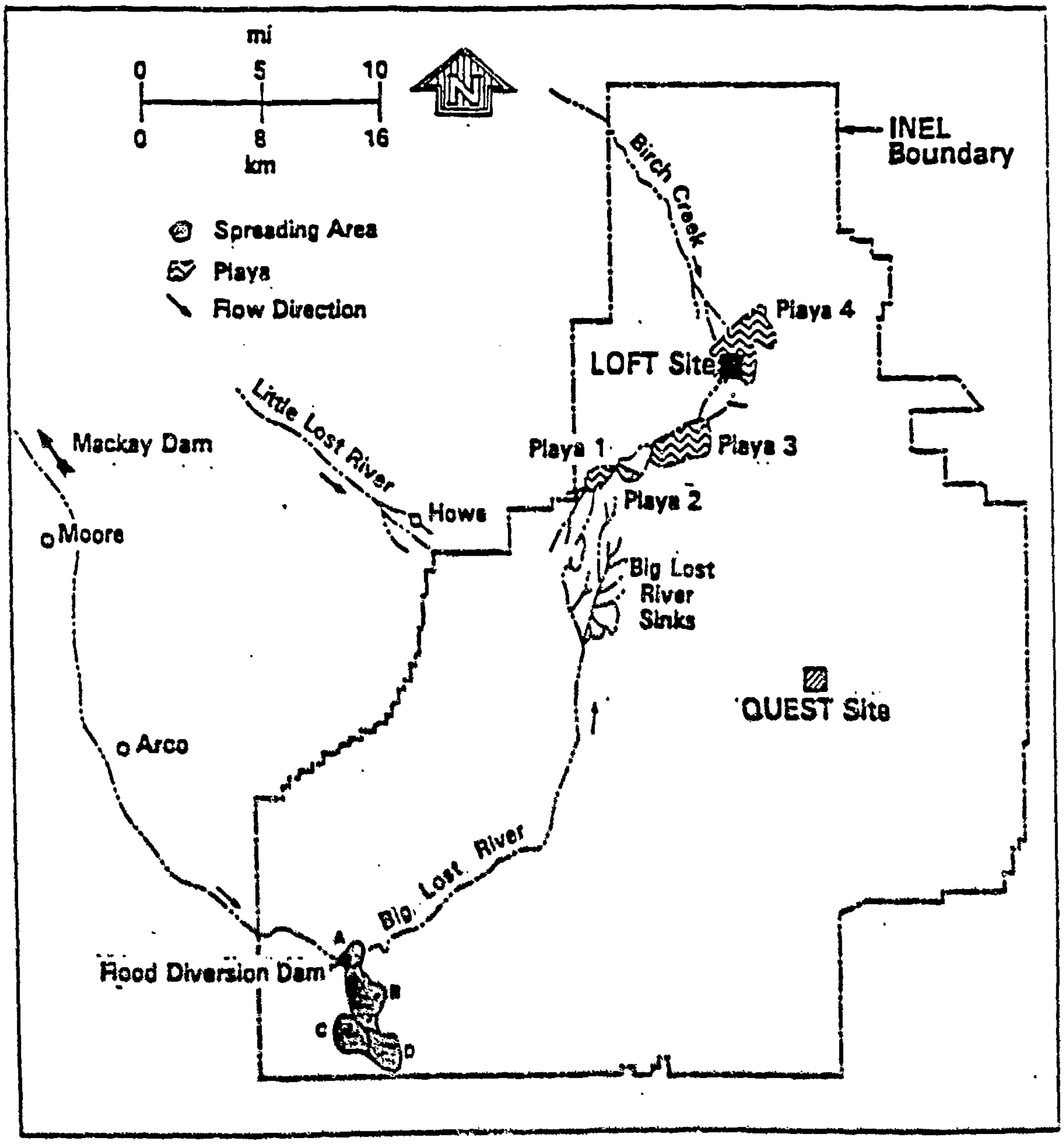

Figure 3.2-14 (U)

Surface Water Features in the Vicinity of INEL (U)

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storage and diversion structures on the Big Lost River are the Mackay Dam and the INEL flood diversion dam. The INEL flood diversion system consists of a small dam that functions to divert the river flow away from INEL facilities into four spreading areas.

(U) Most of the flow from the Little Lost River and from Birch Creek is diverted for irrigation before reaching the INEL. In high-flow years, however, Little Lost River and Birch Creek flow onto the site. There, the remaining water evaporates or infiltrates into the ground through the stream channel or playa bottom (DOE, 1984b). Because of the upstream diversions of water, flooding under normal conditions does not occur within the INEL. A maximum possible flood resulting from maximum flows combined with upstream dam failure would inundate the entire Big Lost River floodplain and the playas in which the river terminates.

(U) In the vicinity of the QUEST site, water from precipitation and snowmelt generally infiltrates into the ground; during occasionally heavy rains or rapid snowmelt, water flows into shallow depressions forming small ponds, playas, or puddles that quickly become dry following rains. The QUEST site lies well beyond the limits of the maximum possible flood on the Big Lost River.

(U) The LOFT facility and the entire Test Area North (TAN) are located within the margins of the Birch Creek playa. The playa is the terminus of both Birch Creek and Big Lost River, and has a minimum elevation of about 592 meters (1,775 feet) above MSL. The playa is normally dry and contains discontinuous shallow pools of water only for short periods after heavy rains. Because of the upstream diversions for irrigation, waters from Birch Creek and Big Lost River do not reach the playa under normal conditions. Maximum flow conditions in these streams combined with the failure of water control structures, however, would flood the playa to undetermined depths. Flood control facilities have been constructed in the LOFT area to prevent flooding of the LOFT facility. These flood control facilities consist of low dikes and interconnected drainage ditches.

(U) Ground Water Resources: Large volumes of ground water occur in the bedrock aquifer beneath the Snake River Plain. The water occurs chiefly in fractures and voids in the basaltic lava flows that underlie the plain. In INEL, the ground water flows to the south and southwest and discharges about 6.5 million acre-feet annually to springs that feed the Snake River below Twin Falls, 160 km (100 mi) from INEL. Ground water flow rates range from 5 to 20 feet per day. Depth to the water table ranges from about 60 meters (200 ft) in the northeast to 300 meters (1,000 ft) in the southern part of INEL. Recharge to the Snake River Plain aquifer is primarily by infiltration from streams to the northwest, north, and northeast of INEL especially the Big Lost River.

(U) The DOE Idaho Operations Office has negotiated with the Idaho Department of Natural Resources a claimed water right for 2.3 m^3/s (81 ft^3/s) [not to exceed 43 million m^3/yr (1.5 billion ft^3/yr)] withdrawal capacity under the Federal Reserve Doctrine. The State of Idaho has signed a Settlement Agreement and there have been public hearings. Based on these hearings, an Interlocutory Order will be generated. The INEL will abide by this Order as it affects water use until the adjudication process is complete. Currently INEL withdraws an average of 0.25 m^3/s (9 ft^3/s) [(7.9 million m^3/yr (280 million ft^3/yr)] (DOE, 1991).

[redacted]

(U) Ground Water Quality: Ground water quality in the Snake River Plain aquifer in the vicinity of INEL meets drinking water standards (DOE, 1991a). The average total dissolved solid content at INEL is low, ranging from 200-255 mg/l consisting mainly of calcium, magnesium, sodium, and potassium. The composition of the ground water indicates reaction with minerals in rocks of the surrounding mountains and alluvial valleys where the residence time of the ground water is relatively long.

(U) The INEL was placed on the National Priorities List during 1989 to facilitate cleanup and monitoring of contaminated areas including an injection well located at Test Area North (TAN) in close proximity to the LOFT facility. Disposal of liquid effluents generated by operations at the Technical Service Support Facility into a well between 1955 and 1972 resulted in small accumulations of two volatile organic compounds along with small amounts of low level radioactive contamination in the sediments. Concentrations of trichloroethylene (TCE) at one point exceeded the EPA maximum contaminant level in drinking water. Removal of a 60 ft. column of sediment in the former injection well was completed in 1990. An aeration system was installed to remove the TCE from the water before it reached the distribution system and the drinking water is monitored monthly to ensure that concentrations remain at safe levels. With the removal of the source of the contaminants it is anticipated that concentrations in the water will gradually decrease.

(U) There has been no subsurface investigations at the QUEST Site. Extrapolation from the nearest wells show that the static ground water level is expected to be at a depth of approximately 140 meters (460 ft) beneath the QUEST site. Ground water flow is southwest toward the Big Lost River valley. Although no ground water analyses have been performed in the vicinity of the proposed QUEST site, groundwater quality is expected to be good because of the site's location upgradient from any effluent discharges on INEL.

3.2.2.2.5 Meteorology and Air Quality (U)

(U) The INEL is situated in a semi-arid climatic region. As a result of the moderating effect of the Pacific Ocean, winters are generally warmer and summers cooler than in locations in a more temperate climate at the same latitude. Average monthly temperatures at the INEL range from -9° C (16° F) (January) to 20° C (68° F) (July) (DOE, 1984b). The annual average relative humidity is 50%, with monthly average values ranging from 30% in July to 70% in February (DOE, 1991a). The average annual precipitation at INEL is 22 cm (9 in). Most of the precipitation is lost through evapotranspiration, except for that portion that percolates through the root zone during the spring thaw or prolonged rainfall.

(U) The INEL is in an area where severe weather, mostly consisting of thunderstorms and tornadoes, occurs relatively infrequently. The frequency of thunderstorms is considered low, with an average of two or three thunderstorms a month in the summer. Although small hail frequently accompanies these storms, damage due to hail is generally not a consideration at the INEL. Tornadoes at or near the INEL also have a very low frequency. The annual probability of a tornado striking at the INEL is 7.8×10^{5} (DOE, 1984b).

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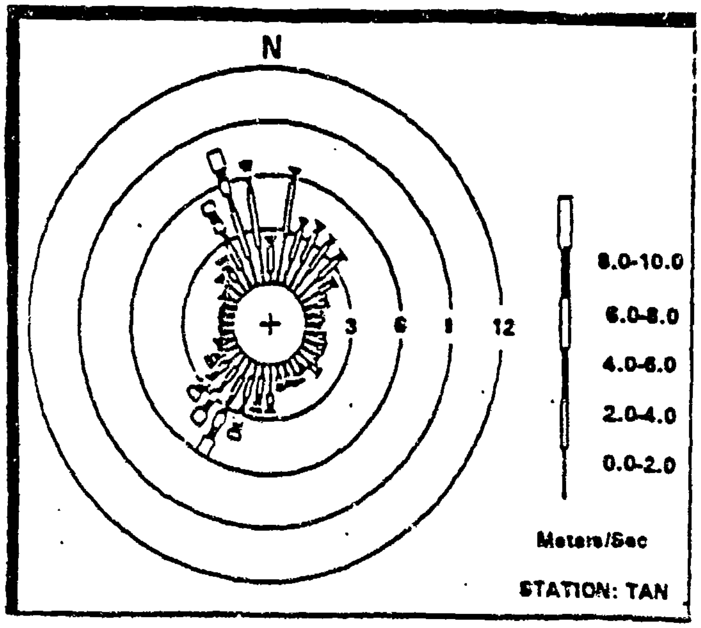
(A) LOFT - Test Area North (TAN)



(B) Argonne National Laboratory (ANL)

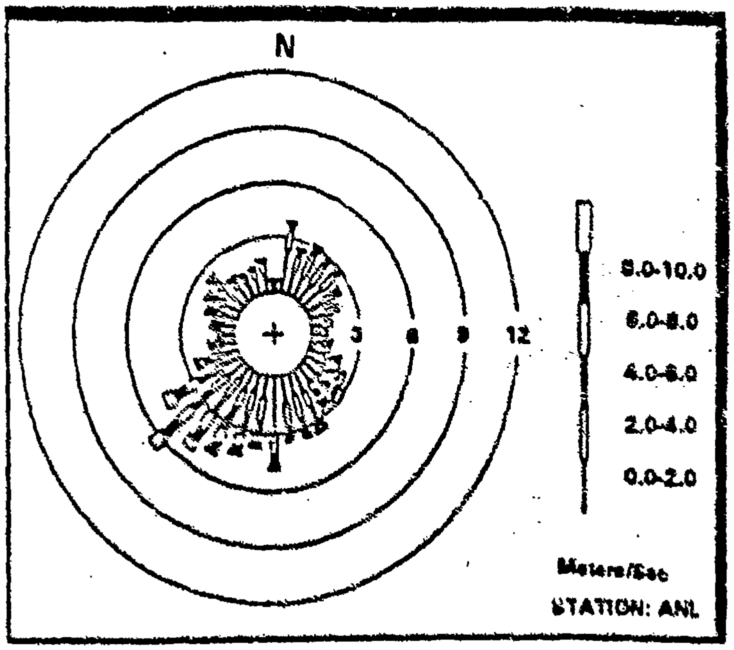


Figure 3.2-15 (U)

Joint wind speed direction and frequency distributions (wind roses) for: (A) Loss of Fluid Test (LOFT) facility at Test Area North and (B) Argonne National Laboratory during 1980-1982 [DOE Climatology Report, 1989].

[redacted]

TABLE 3.2-4
AMBIENT AIR QUALITY STANDARDS APPLICABLE TO INEL AND MAXIMUM ESTIMATED BACKGROUND CONCENTRATIONS (STANDARDS AND CONCENTRATIONS ARE IN $\mu g/m^3$) (U)

Pollutant	Averaging Time	Idaho State Standards[a]	Primary NAAQS[b]	Secondary NAAQS[b]	Maximum Background Concentration
SO_2	Annual	80	80	c	0.2
	24 h	365	365	c	8
	3 h	1,300	c	1,300	14
PM					
TSP[d]	Annual[e]	60	c	c	40
	24 h	150	c	c	88
PM_{10}	Annual[f]	50[g]	50	h	14
	24 h	150[i]	150	h	32
CO	8 h	10,000	10,000	h	j
	1 h	40,000	40,000	h	j
O_3	1 h	235[k]	235	h	j
NO_2	Annual	100	100	h	0.6
Pb PM	Calendar quarter	1.5	1.5	h	j

[a] (U) The Idaho State annual standards are never to be exceeded; short-term standards are not to be exceeded more than once per year, unless otherwise noted.

[b] (U) The NAAQS, other than those for O_3 and PM_{10} and those based on annual averages, are not to be exceeded more than once per year. The O_3 standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is less than or equal to one. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to one. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[c] (U) There is no standard.

[d] (U) The TSP standards have been replaced by standards for PM_{10}.

[e] (U) Geometric mean of all values reported during the year.

[f] (U) Arithmetic mean of the quarterly arithmetic means for the calendar quarters of the year.

[g] (U) The attainment condition is the same as that for the annual NAAQS for PM_{10}.

[h] (U) Same as for the primary standard.

[i] (U) The attainment condition also includes that for the 24-hour NAAQS for PM_{10}.

[j] (U) Data are unavailable.

[k] (U) The attainment condition is the same as that for the NAAQS for O_3.

[redacted]

(U) Ambient air quality within and near the INEL site boundary is currently monitored for SO_2 (one location), NO_2 (two locations), and particulate matter (PM), (two locations for TSP). These stations are located in the vicinity of the Idaho Chemical Processing Plant in the southwestern portion of INEL. The ambient air quality data collected during the last few years indicate that concentrations of SO_2 and NO_2 and TSP are well below the applicable ambient standards or increments.

(U) The Idaho Department of Health and Welfare (IDHW) no longer monitors ambient ozone (O_3) or NO_2 because previous monitoring indicated that ambient concentrations were very low. Monitoring of ambient lead concentrations in Idaho's large cities yielded concentration levels that were only a small fraction of the applicable ambient lead standard.

(U) All nuclear testing operations have been conducted in accordance with the NESHAP for radionuclide emissions of 10 millirem/year effective dose equivalent at off-site locations. Calculated maximum off-site dosage using the EPA model AIRDOS is approximately .0009 mrem/yr for all radionuclides, which represents only .01% of the NESHAP standard for radionuclide emissions (DOE, 1990e).

3.2.2.3 Biological Resources (U)

(U) This section includes a discussion of the flora and fauna found at INEL with a brief discussion of biological resources at the QUEST and LOFT sites.

3.2.2.3.1 Terrestrial Biota (U)

Flora (U)

(U) Based on the presence of dominant vegetation, six major vegetative communities occur on and adjacent to the INEL. These are sagebrush, juniper, crested wheatgrass, Indian ricegrass, and agricultural and wetlands vegetation. Sagebrush is the dominant community type. Juniper communities occur in the northwest and southeast portions of the site and are associated with higher elevations. Although these communities are restricted in distribution they provide important nesting habitat for raptors and are used by a number of passerine species. Seeded Crested wheatgrass areas total about 40 square kilometers (10,000 acres) and occur throughout the INEL. Indian ricegrass communities are found in a narrow band near the eastern site boundary. Irrigated farmland borders about 37 percent of the site and approximately sixty percent of the INEL is open to grazing by livestock. Over 800 hectares (2,000 acres) of wetlands may occur on INEL during periods of high waterflow in the Big Lost River. Wetland vegetation is characterized by sedges, cattails, and bulrushes. Riparian vegetation consists primarily of cottonwood and willows.

(U) A reconnaissance level survey conducted at the QUEST site determined that the area is located within the sagebrush community, specifically the big sagebrush/Indian ricegrass/needle-thread type. Juniper and pinyon trees were found scattered throughout the area at higher elevations. Portions of the QUEST Site have minimal vegetative cover especially in areas covered by basaltic rock.

[redacted]

(U) The LOFT facility is located within a disturbed area that is primarily vegetated by rabbit brush and other invader species. Other plant species found in the vicinity of LOFT include saltbrush and Indian ricegrass (DOE, 1991a). Crested wheatgrass has been planted along the roadways.

Fauna (U)

(U) One species of amphibian and nine species of reptiles have been recorded on the INEL. Based on published ranges, an additional five amphibian and five reptile species may also be found (DOE, 1991a). The Great Basin spadefoot toad, the only amphibian observed, is found in the big Lost River sinks and spreading areas. Of the nine reptile species occurring there, the short-horned lizard, sagebrush lizard, gopher snake, and western rattlesnake occur commonly throughout the INEL.

(U) A total of 184 bird species have been observed at various times of the year on the INEL (DOE, 1991a). The sage sparrow, horned lark, Brewer's sparrow, black-billed magpie, robin, and sage thrasher are the most common passerine breeding species. The sage grouse and mourning dove are the most common upland game birds; both breed throughout the site. The most common raptor species that are found on the INEL during the breeding season include the American kestrel and the Long-eared owl. The most abundant raptors observed during the nonbreeding season include the American rough-legged hawk, American kestrel, prairie falcon, and golden eagle. Migratory bird species listed in the Migratory Bird Act also occur at INEL (Appendix E).

(U) Thirty-seven species of mammals are known to occur on the INEL site. Of these, 18 are rodents, 4 are leporids (i.e., hares and rabbits), 6 are carnivores (coyotes, long-tailed weasel, and badger are most common), and 9 belong to other groups. The INEL supports resident populations of mule deer and pronghorn. Mule deer are considered uncommon and are generally concentrated in the southern and central portion of the INEL. They occur in greater numbers on the buttes and mountains surrounding the INEL. Pronghorn are found throughout the INEL and are generally considered abundant. Most pronghorn in southeastern Idaho are migratory. During winter, 4,500 to 6,000 pronghorn, or about 30% of Idaho's total population, may be on the INEL (DOE, 1988a).

(U) A reconnaissance-level survey of the QUEST site determined that the animal habitat present there appears typical of other areas of INEL. Resident fauna at the QUEST Site are typical of those found in the sagebrush community. Evidence of rabbits and owl was found during the survey. In addition, pronghorn antelope, a mule deer and a coyote were observed in the vicinity of the site.

(U) The LOFT Site is not considered to be important wildlife habitat because the area has been largely disturbed by previous construction and operation activities.

3.2.2.3.2 Aquatic Biota (U)

(U) Wetlands may temporarily exist on the INEL during periods of high water flow in the Big Lost River providing habitat for migratory water fowl, shore birds and other wildlife species. Riparian wetland vegetation (primarily cottonwoods and willows) along the Big Lost River and along Birch Creek (which enters the northern part of INEL and flows south into the sink area) provides nesting habitat for hawks, owl, and numerous songbirds (DOE, 1991a). No aquatic resources including designated wetlands are located on the QUEST site. The LOFT facility is located approximately one mile from Birch Creek and the Big Lost River which provide habitat for the aquatic resources described in the previous paragraph. However, none of these resources including designated wetlands are known to exist in the vicinity of the LOFT facility.

3.2.2.3.3 Endangered and Threatened Species (U)

(U) No federally listed threatened or endangered plants are found on the INEL but two species of milk-vetch are candidates for listing (DOE, 1991a). The bald eagle and the American peregrine falcon are the only animals observed that are classified by the Federal government as endangered or threatened. The bald eagle (endangered) usually winters on or near the INEL. The peregrine falcon (endangered) has been observed infrequently in the northern portion of the site. There are no raptor species on the INEL proposed for listing as endangered or threatened. The Swainson's hawk (Buteo swainsonii) and ferruginous hawk (Buteo regalis) are two additional raptors occurring as candidate species for classification as endangered on the threatened. Both Swainson's hawks and ferruginous hawks are uncommon migrants, uncommon summer breeders, and rare winter visitors to the INEL. The Townsend's western big-eared bat, also a candidate species, roosts in caves on INEL. The FWS recommends that impacts to candidate species be considered in project planning since these species may become listed at any time.

3.2.2.4 Background Radiation (U)

(U) This section provides information on environmental radiation, radiation sources, radiation, and environmental radiation monitoring program.

3.2.2.4.1 Environmental Radiation Sources and Exposure (U)

(U) Environmental radiation consists of natural background radiation from cosmic, terrestrial, and internal body sources. Additional sources of background radiation are medical and dental diagnosis, nuclear weapons test fallout, consumer and industrial products, air travel, brick and stone buildings, and radioactive releases associated with INEL operations.

(U) Natural background radiation contributes about 54 percent of the annual dose of 266 millirem received by an average member of the population within 80 km (50 mi) of the INEL. Medical exposure accounts for 34.7 percent of the annual dose; brick and stone buildings in the area account for 7.5 percent of the annual dose; and combined doses from consumer and industrial products and air travel account for 1.9 percent of the annual dose. The radioactivity released to the environment from the INEL accounts for less than 0.1 percent (0.1 millirem per year) of the total annual dose.

(U) The results of the various monitoring programs for 1989 indicate that most radioactivity from the INEL operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEL site. Although some radioactive materials were discharged during Site operations, concentrations and doses to the surrounding population were of no health consequence and were far less than the State of Idaho and Federal health protection guidelines. Using the AIRDOS-EPA and RADRISK codes, a 1989 total-body dose equivalent of 0.0009 mrem was calculated for "members of the public at the point of maximum annual air concentration in an unrestricted area where any member of the public resides or abides" (40 CFR 61, Subpart H). This dose represents only .01% of the NESHAP standard for radionuclides (DOE, 1988a).

3.2.2.4.2 Environmental Radiation Monitoring Program (U)

(U) Environmental monitoring programs at the INEL are conducted to determine: (a) the overall impact of DOE operations on the environment, (b) whether environmental levels of radioactivity comply with applicable standards (40 CFR 61, DOE Order 5400.3), (c) whether containment and control systems at facilities are functioning as planned, and (d) long-term trends of concentrations of radioactivity in the environment and any changes in those trends. Environmental impacts are determined by measuring radionuclides in the environment, where such measurements are possible, or by modeling the transport of radionuclides through environmental pathways in cases where environmental concentrations are too low to measure. Measurements on the INEL or at the INEL boundary are frequently compared to similar measurements at background or control locations, especially in cases where concentrations are compared to applicable environmental standards. Where radionuclide concentrations are high enough to be measured regularly, long-term trends are presented. Data are reported yearly in an environmental monitoring report for the INEL (DOE, 1990b).

(U) The environmental pathways by which radioactivity could affect the population in the vicinity of the INEL are through direct radiation exposure, through atmospheric transport, and through soils, water, foodstuffs, an/or animals. The environmental monitoring program for the INEL site and vicinity includes the collection and analysis of samples from these potential exposure pathways.

(U) Air and water are routinely monitored for radioactivity at a number of on-site as well as boundary and distant locations. Concentrations of radionuclides in milk, wheat, and lettuce samples are measured at site-boundary and distant locations. Distant locations serve as background controls that are not affected by radioactive releases associated with INEL operations. On-site soils are sampled annually on a rotating basis, while off-site soils rates are sampled only in even-numbered years. Environmental radiation exposure rates are measured at the site-boundary and at distant locations. Based on monitoring data no significant concentrations of radionuclides from the INEL have been detected. A brief discussion of major pathways is presented below.

(U) Airborne particulate radioactivity is monitored continuously by a network of 12 samplers on-site and 11 samplers off-site. On-site samplers are located to give adequate coverage in the event of INEL facility releases of radioactivity. Seven off-site samplers are located near the site

boundary in communities, where possible. The remaining off-site samplers are located at distant communities to provide background measurements for comparison with data from boundary or on-site samplers that might be affected by site operations. The background (distant) locations are usually in a crosswind direction to the site and are sufficiently remote to ensure that radioactivity detected is primarily due to natural background or sources other than site operations. (All the reported results of specific nuclides were very near the minimum detectable concentration.)

(U) The analytical methods for environmental samples are carefully reviewed to verify that such analyses are made with sufficient sensitivity to verify compliance with appropriate standards. High reliability is obtained by a stringent quality assurance program. Gross counting of samples is used for establishing trends or for screening groups of samples.

(U) Because the expected INEL contribution to off-site dose rates is small, it cannot be directly measured reliably. The most sensitive indicators of radiological impacts of INEL operations are the analyses of samples for individual radioisotopes. The minimum detectable concentrations for most radioisotopes permit calculation of dose commitments to the public of 0.1 millirem per year or less.

(U) The Snake River Plain aquifer that lies beneath the INEL site serves as the primary source of drinking water and irrigation water for crops in the Snake River Basin. On-site and off-site water samples are collected routinely to monitor for movement of waste substance through the aquifer. Tritium, strontium-90, and iodine-129 are found in aquifer samples obtained on-site. The extent of these radionuclides in the aquifer is documented in U.S. Geological Survey (USGS) reports. Over the last few years, concentrations of these radionuclides in the aquifer have generally been decreasing. Detectable contractions of several other radionuclides have been found in on-site aquifer wells close to the source of the nuclides. Gross alpha, gross beta, and tritium analyses are performed on drinking water samples. The average gross alpha concentration for 1989 samples was 1.9 x 10^{9} μCi/ml. This average is within the expected concentration range of 1.5 x 10^{9} to 2.5 x 10^{9} μCi/ml for naturally occurring alpha activity in the aquifer underlying the INEL and surrounding areas. Gross alpha concentrations in all samples were less than the EPA community drinking water standard for gross alpha activity of 15 x 10^{9} μCi/ml. Forty-four of the 280 site samples and nine of the fifty-four boundary and distant samples showed gross beta concentrations of 8 $\pm$ 4 x 10^{9} μCi/ml or lower, i.e. near the minimum detectable concentration. Annual averages for gross beta activity at all locations were below the EPA community drinking water standard of 50 x 10^{9} μCi/ml.

(U) Milk, wheat, and leafy garden lettuce are sampled routinely and analyzed for radioactivity. All concentrations of iodine-131, strontium-90, and tritium in milk are well below health protection guides. Wheat and lettuce sampling results showed that the concentration of strontium-90 was near or less than the minimum detectable concentrations. Muscle and liver samples were taken in 1985 from sheep that had grazed in the northern and eastern grazing areas of the INEL site. No man-made radionuclides were detected in either the muscle or liver samples of the sheep that had grazed on the site (Appendix G).

[redacted]

(U) Thermoluminescent dosimeters (TLDs) are used to measure ionizing radiation exposures at 135 on-site locations, 6 boundary locations, and 6 more distant locations. The TLDs measure ionizing radiation exposures from natural radioactivity in the air and soil, cosmic radiation from outer space, fallout from nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive emissions from site operation and other industrial processing. The mean annual TLD exposures for both boundary and more distant locations are generally in the range of 110 to 115 millirem.

(U) Samples of air, precipitation, drinking water, and milk from Idaho Falls and Snake River water from Buhl, Idaho, are analyzed independently by EPA's Eastern Environmental Research Facility. Under a working agreement between the state of Idaho and the DOE, environmental samples collected by the Radiological and Environmental Sciences Laboratory (RESL) or the USGS have been split with Idaho. In addition, the DOE, in consultation with the State of Idaho, is establishing a contract with Idaho State University to provide independent verification of the environmental monitoring program at the INEL. The DOE will fund the program, and Idaho State University will furnish its findings to DOE and the State of Idaho.

[redacted]

4.0 ENVIRONMENTAL CONSEQUENCES (U)

(U) The [redacted] program has the potential to affect both the natural and the human environment. This section describes the environmental consequences or impacts that could result from continued materials and component testing and construction of the ground test facility in support of the [redacted] Program.

(U) The material in this section is organized by location in parallel to the environmental descriptions in Section 3.0. Section 4.2 discusses the environmental consequences of program activities that are conducted at the materials and component facilities. Sections 4.3, 4.4, and 4.5 discuss the environmental consequences of construction and operation of the ground test facility at the Saddle Mountain Test Station (NTS), the QUEST Site (INEL), and the LOFT Site (INEL), respectively.

(U) State and Federal regulations pertaining to [redacted] environmental issues are presented in Appendix E.

4.1 METHODOLOGY (U)

(U) This section presents the methodology for assessing impacts and significance associated with the proposed action and alternatives for each of the environmental resources addressed in the EIS. The types and levels of impacts are discussed within each subsection.

([redacted]) A systematic, interdisciplinary approach to impact analysis was implemented. The approach involved the collection and review of secondary data regarding program technology and regional information for the Continental United States (CONUS). As data gaps were identified and the need for more specific information became known, primary data collection and research began. This involved contacting and meeting with experts and contractors involved in the research, development, and manufacturing of materials and components related to PBR and related technologies.

(U) At the same time, investigations began to identify suitable sites for the ground testing facility. The results of these investigations are summarized in the Site Narrowing Report in Appendix C. This study resulted in the identification of three alternative sites at DOE installations; one at the Nevada Test Site (NTS) and two at the Idaho National Engineering Laboratory (INEL). As part of the primary data collection effort, personnel at the NTS and INEL installations were contacted to obtain additional source documents and first hand information about the characteristics of the three alternative sites being considered for the ground test facility.

([redacted]) Contractors and installation personnel have remained involved in the [redacted] program throughout the environmental analysis process to provide accurate technical information regarding PBR technology and site and regional characteristics.

(U) Following data collection and analysis, methods for analyzing the potential environmental impacts were developed and modeling techniques were applied where appropriate (including the

RADTRAN model for transportation impacts and the MACCS model for calculating radiation dose exposures).

(U) Significance of the impacts is determined by applying criteria established by the Council on Environmental Quality in regulations implementing the procedural provisions of the National Environmental Policy Act (40 CFR Parts 1500-1508). Significance, as presented under the CEQ regulations, requires considerations of both context and intensity. The significance of an action must be analyzed in several contexts. For example, impacts may be significant in the immediate surroundings of the proposed test site location, but not significant within the context of the entire DOE installation or surrounding community. Intensity refers to the severity of the impact. The criteria established by CEQ are shown below:

1) Both beneficial and adverse impacts must be evaluated.
2) The degree to which the proposed action affects public health and safety.
3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, parklands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.
5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
6) The degree to which the action may establish a precedent for future actions with significant effects.
7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts.
8) The degree to which the action may adversely affect objects listed in, or eligible for listing in the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historical resources.
9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
10) Whether the action threatens a violation of federal, state or local law or requirements imposed for the protection of the environment.

(U) Based on preliminary research and analysis, levels of impact intensity were established for each of the environmental resource categories included in the impact analyses. The definitions of these levels of impacts (negligible, low, moderate, and high) are presented in Appendix D. It was also established during the analysis that impacts in the negligible and low categories are insignificant and those in the moderate and high categories are potentially significant.

(U) The area of study encompasses the area within which project effects of any magnitude, both direct and indirect, might be expected to occur. This area of study depends on the region of influence for each environmental resource category included in the analysis. Region of influence refers to the area around the ground test facility that has the potential to be impacted by [redacted] program construction and operation activities. The size and characteristics of the region

varies according to the particular environmental resource under consideration. The region of influence for each resource is defined as follows:

<u>Population and Economy</u> (U)

(U) Potential impacts to the population and economy resource category result from the increased demands placed on governmental jurisdictions to provide facilities and services (i.e., education, health care, public safety, etc.) for increased population and economic activities associated with the construction and operation of the program. The population and economy region of influence is defined as the area within commuting distance of the site where inmigrating workers and their families may locate and require additional community facilities and services.

<u>Land Use and Infrastructure</u> (U)

(U) The region of influence for land use includes the 40 hectares (100 acres) required for the ground test facility construction, the area that may be precluded from existing public use activities during operations, the area within a 3 kilometer (2 mile) radius of the test facility restricted from grazing during normal operations, and any area that could be potentially contaminated by radioactivity in the unlikely event of accident. The region of influence for infrastructure includes the region within which existing infrastructure (i.e. electrical, water, transportation systems, etc.) may be affected by the Program activities.

<u>Noise</u> (U)

(U) The region of influence for noise is broadly defined as the area in which increases in noise level are perceived as noticeable by the receptor.

<u>Cultural Resources</u> (U)

(U) Potential impacts to cultural resources result from ground disturbance during construction activities. The region of influence for cultural resources is the 40 hectares (100 acres) of land required for the ground test facility and any additional land required for supporting infrastructure (i.e., access roads, power lines, water lines, etc,).

<u>Safety</u> (U)

(U) The region of influence for non-nuclear safety is the test facility site during construction and the area of potential impacts from process fluids accidents during the operation period. This is the area susceptible to injury or damage from projectiles or from a detonation/deflagration in the unlikely event of an explosion.

<u>Waste</u> (U)

(U) The region of influence for waste is the test facility site where the waste is generated as well as the areas required for storage and ultimate disposal.

[redacted]

Topography (U)

(U) The region of influence for topography is the 40 hectares (100 acres) required for the ground test facility and any additional land required for supporting infrastructure (i.e., access roads, power lines, water lines, etc,).

Geology (U)

(U) The region of influence for geology is the 40 hectares (100 acres) required for the ground test facility and any additional land required for supporting infrastructure (i.e., access roads, power lines, water lines, etc,) and construction materials.

Seismic/Volcanic Activity (U)

(U) The region of influence for seismic and volcanic activity is the area where construction or operational testing could trigger seismic or volcanic events which would be noticeable to instrumentation or human observations.

Water Resources (U)

(U) There are two regions of influence for water resources. One is the area containing any surface bodies of water with sufficient quantity and quality of water to supply project needs and/or experience water quality degradation and water supply depletion from program construction or operation activities. The second is the area encompassing the aquifer which could supply project water needs or be susceptible to water quality degradation and water supply depletion from project construction or operation activities.

Meteorology/Air Quality (U)

(U) The region of influence for meteorology and air quality includes the area encompassed by the Intrastate Air Quality Control Region (AQCR) within which the ground test site is located.

Biological Resources (U)

(U) The region of influence for biological resources is the area where resources may be affected directly or indirectly by the Program. For construction activities the region of influence is the 40 hectares (100 acres) required for the ground test facility and any land required for supporting infrastructure (i.e., access roads, power lines, water lines, etc,). For operation activities, the region of influence is the 80 kilometer (50 mile) radius from the reference point used for the radiological analyses.

Radiological Impacts (U)

(U) The region of influence for potential radiological impacts is the 80 kilometer (50 mile) radius from the reference point used for the radiological analyses, and the population centers within that radius.

[redacted]

(U) Like any new technological development program the [redacted] program contains within it an element of uncertainty. Because of the inherent programmatic uncertainty, the impacts emanating from the program also contain a degree of uncertainty.

([redacted]) Four actions have been taken to reduce the uncertainty associated with the [redacted] program impacts. First, the resources of the most applicable experts in many fields have been and would continue to be applied to the research program. This includes experts from the fields of nuclear engineering, aerospace engineering, and materials development, among others. Second, the development program is an incremental program that ensures the integrity and soundness of each step of the program before proceeding further. Third, safety analyses are performed for each aspect of the testing including material and component testing, ground testing, and flight testing. And fourth, conservative assumptions are used in all impact analyses.

4.2 MATERIALS AND COMPONENTS DEVELOPMENT, FABRICATION, ASSEMBLY AND TESTING FACILITIES (U)

([redacted]) This section describes the environmental consequences of the [redacted] program activities at the materials and components facilities. The environmental consequences of each facility do not affect the ground test facility (i.e. wastes generated at each contractor facility are entered into the normal waste stream for that facility and do not affect the waste stream of the ground test station). The facilities that are discussed in this section include Brookhaven National Laboratory, Babcock and Wilcox Naval Nuclear Fuel Division, Sandia National Laboratories, Aerojet Propulsion Division, Hercules Aerospace Corporation, Garrett Fluid Systems Division, Airesearch Los Angeles Division, and Grumman Space Electronics Division.

4.2.1 Brookhaven National Laboratory (U)

([redacted]) [redacted] activities that are being performed at Brookhaven National Laboratory (BNL) primarily involve the development of refractory materials and coatings for the fuel particles and the hot frit. Experiments at BNL are carried out using existing furnaces and other existing material testing laboratory equipment and procedures. There is a low impact on facility infrastructure due to minor laboratory or laboratory equipment modifications that are required for each set of experiments. These modifications are normally handled by BNL personnel with some on-site equipment manufacture supported by suppliers. Minor facility modification is required to conduct the Element Blowdown Testing (BNL, 1991). Mitigations for the impact on infrastructure include planning activities to increase the efficiency of procedures and equipment. No additional hiring would be required to complete [redacted] activities. No additional utilities would be required, however, the existing electrical supply might have to be conditioned to be compatible with use in an experiment (BNL, 91).

([redacted]) There is a noise issue associated with the seven element blowdown experiment. While the test is conducted, hydrogen is vented from the test area to the outside that causes noise levels estimated to be in excess of 105 dBA for less than one second duration. The OSHA limit of 115 dBA for 15 minutes duration is not applicable due to the extremely short duration of the noise exposure. However, based on the methodology, the noise impact on personnel in the vicinity of the test area is considered to be moderate because the predicted noise level would exceed ambient noise levels by 35 dBA but would not exceed OSHA limits. Since, on-site personnel would be inside the laboratory at least 20 meters (60 feet) from the test area and since the test area is remote from other BNL facilities and the public, the environmental consequences would be insignificant.

(U) The possibility of a hydrogen detonation/deflagration during the blowdown experiment would result in a moderate impact on safety and would therefore be potentially significant.[1] The potential impact can be mitigated by designing, operating, and maintaining the hydrogen system in accordance with all appropriate NFPA, CEA, and ASCE standards to ensure sufficient

[1](U) See Section 2.4.3 for more detailed discussion of hydrogen safety issues and Section 4.3.1.5 for discussion of consequences of leaks and detonation/deflagration.

protection for both personnel and on-site equipment. (Of particular note is NFPA Pamphlet No. 50A for gaseous hydrogen and NFPA 50B for liquid hydrogen.) In addition, procedures outlined in the BNL Safety Manual for the safe handling and transport of compressed gas cylinders would be followed. Hydrogen, both liquid and gaseous, is routinely handled at a number of NASA, DoD, private industry, and non-profit research centers around the United States.

([redacted]) The potentially significant safety impact would be mitigated to levels of insignificance. All other environmental consequences of the [redacted] program activities at BNL are expected to be insignificant because they take place in slightly modified existing facilities and are carried out by existing personnel. The activities are within the scope of routine operations at BNL.

4.2.2 Babcock and Wilcox (B&W) (U)

([redacted]) Activities to be performed at the B&W Naval Nuclear Fuel Division (NNFD) in support of the [redacted] program include analysis, design and fabrication of fuel particles and reactor components. Some facility modification was required in order to complete fuel manufacturing activities resulting in a low impact on facility infrastructure. Mitigations for the impact on infrastructure include planning activities to increase the efficiency of procedures and equipment. The proposed facility modification plans were subjected to the facility modification review process to ensure that all safety and licensing considerations were adequately addressed. The [redacted] program activities, including manufacturing, testing, and administrative would utilize less than one percent of the total B&W facility space at the Mt. Athos site. All employees involved in program activities are considered baseline with no increase in total B&W employment.

([redacted]) The [redacted] program activity descriptions were reviewed and the NNFD Licensing management representative determined that these proposed activities were within the scope of routine operations currently authorized at B&W by existing licenses SNM-42 and SNM-778. (There are no parts or provisions of these licenses that are specific to the [redacted] program). Specific operations, however, would require detailed safety analyses and subsequent review/approval by the Internal Nuclear Licensing Board through the License Evaluation Request system[2]. The impact of storage and handling of Special Nuclear Material (SNM) on facility safety is anticipated to be negligible as there are adequate facilities to provide for accountability and approved safe storage of the SNM. The SNM inventory for the [redacted] program would account for only a small percentage of NNFD's possession limit of 60,000 kgs (66 tons) of U-235.

([redacted]) Program activities would have a negligible impact on waste operations at B&W. Low-level radioactive waste generated at B&W is shipped to Chemical Nuclear Systems Inc., a licensed and approved treatment, storage, and disposal (TSD) facility located at Barnwell, South Carolina, for disposal. The quantities of low-level radioactive waste that would be generated

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[2]([redacted]) The Internal Nuclear Licensing Board review is a part of B&W's normal safety and licensing activities and would review all modifications through internal processes.

from [redacted] activities are estimated to be less than 1 kg (2.2 lbs) per month. The waste would be combined with other B&W LLW and shipped in DOT certified containers on an exclusive-use vehicle. Small quantities of mixed waste in the form of contaminated trichloroethylene (TCE) would be generated and stored on-site. No high level radioactive waste would be generated.

([redacted]) The impacts of the [redacted] program activities at B&W NNFD are expected to be negligible because they take place in slightly modified existing facilities and are carried out by existing personnel. The activities are within the scope of routine operations at B&W. In addition to NRC licenses, B&W has all applicable permits needed to conduct [redacted] program activities. Hazardous wastes generated at B&W are disposed of in accordance with RCRA requirements. Therefore, the environmental consequences would be insignificant.

4.2.3 Sandia National Laboratories (U)

([redacted]) [redacted] program activities that are performed at Sandia National Laboratories (SNL) include the PIPE tests, Critical Assembly Experiments (CX), Particle Nuclear Tests (PNT), and Nuclear Element Tests (NET). Approximately 100 full and part time persons are required to complete the proposed activities in support of the [redacted] program. Since this number represents a small percentage of the total SNL workforce it is anticipated that the impact on the facility infrastructure at SNL would be negligible.

(U) Each [redacted] program test series conducted at SNL has been or would be reviewed by the Sandia Internal Review and Approval System (SIRAS) to ensure that proper safety analyses are performed for each new experiment, and that proposed experiments are properly planned, documented, reviewed and approved.

(U) The CX experiments have been determined by DOE-Albuquerque to fall within the bounds of the types of experiments normally conducted in Area V at the Sandia Pulse Reactor (SPR) facility. Administrative controls assure that the combination of the other SPR facility activities and the CX operations do not exceed the fission product and radionuclide release envelope authorized by DOE for the SPR facility. A NESHAP permit is not required for CX since the CX would not produce any new nuclides (radionuclides which are not presently produced by the SPR).

(U) The PIPE tests have been and the PNT series are being performed in the Annular Core Research Reactor (ACRR). Specific safety analyses were performed as part of the experiment evaluation. Internal SNL reviews concluded that the tests were well within the Technical Specifications envelope, and as a result, DOE-AL concurrence was not required. The NET test series is currently scheduled to begin in late 1991 and would also be reviewed by SIRAS and DOE-Albuquerque to determine if the test series is within the scope of routine operations at SNL.

([redacted]) All wastes generated by the [redacted] program activities at SNL would be stored, handled, packaged, and disposed of in accordance with applicable DOE requirements. The

impact on waste management systems is anticipated to be negligible as all waste generated at SNL from [redacted] activities can be handled under existing operational conditions.

(U) The impact of the [redacted] program activities at SNL are expected to be negligible because they take place within existing facilities and personnel requirements and are within the scope of routine operations at SNL. Therefore, the environmental consequences would be insignificant.

4.2.4 Aerojet Propulsion Division (U)

(U) Fabrication of test subcomponent level hardware for the [redacted] program would be performed by Aerojet at its Sacramento, California facility. Existing facilities would be used for [redacted] program activities and no additional utilities would be required. Combined operations in the machine shop, weld shop, and engineering test area would not exceed one percent of total capability. All areas of the platelet shop would be involved at one time or another but only at about 3% of the total time available. The fifteen people required to complete the proposed activities are currently employed at the facility (Horan, 1990a).

(U) The impacts of the [redacted] activities at Aerojet are expected to be negligible because they take place in slightly modified existing facilities and are carried out by existing personnel. The activities are within the scope of routine operations at Aerojet. Therefore, the environmental consequences would be insignificant.

4.2.5 Hercules Aerospace Corporation (U)

([redacted]) Design, analysis, fabrication, and testing of [redacted] for the [redacted] program would be performed at the Hercules facility in Magna, Utah. These [redacted] are similar to the rocket nozzle components that have been manufactured and tested for other programs with the exception of the requirements for survival in a radiological environment. The design and manufacture of these structures does not constitute a "new" technology at Hercules and represents a very small portion of the normal workload at the facility (Bergstrom, 1991).

(U) All [redacted] activities would take place in existing facilities and do not require the hiring of additional personnel. The materials that are fabricated at Hercules are neither classified nor hazardous and would require no special storage. Wastes as a result of the [redacted] activities would include hot hydrogen gas (GH2) and minute quantities of methane, niobium carbide, and Ta-carbide (Bergstrom, 1991).

(U) The impact of the [redacted] program activities at Hercules are expected to be negligible because they take place in existing facilities and are carried out by existing personnel. The activities are within the scope of routine operations at Hercules. Therefore, the environmental consequences would be insignificant.

4.2.6 Garrett Fluid Systems Division (U)

(U) [redacted] activities conducted by the Garrett Fluid Systems Division (GFSD) are being performed at two locations: GFSD Tempe and GFSD San Tan, AZ.

Activities at Tempe, Arizona (U)

(U) [redacted] program activities that are performed by GFSD at the Tempe, AZ facility include development tests on cryogenic flow control components as well as on the turbine section of the Turbo Pump Assembly (TPA) in various phases. All [redacted] activities would be performed in existing facilities at GFSD. No additional utilities are required to perform the activities. Approximately ten people are needed to complete the proposed activities, all of whom are currently employed at GFSD (GFSD, 1991). There are no regulated emissions or effluents as a result of [redacted] testing and no permits are required.

(U) The impacts of the [redacted] program activities at GFSD are expected to be negligible because they take place in slightly modified existing facilities and are carried out by existing personnel. The activities are comparable in scope to present activities at GFSD and involve materials and material quantities that are routinely used for many other programs at the facility. Therefore, the environmental consequences would be insignificant.

Activities at the San Tan Facility (U)

(U) [redacted] activities performed at the GFSD San Tan facility include development tests that would be conducted on the hydrogen/oxygen combuster and liquid hydrogen capabilities to provide a testing environment for components and sub-assemblies. The Hot Hydrogen Gas Generating (HHGG) test facility is located on a new GFSD lease of 44 hectares (110 acres) of Gila River Indian Reservation land. The impact on land use is anticipated to be negligible as there would be only minor reductions in the supply of vacant developable or usable land. Approximately six people are needed to complete the proposed [redacted] program activities, there would be no new additions to the present baseline staff requirements at the San Tan facility.

(U) The additional on-site utilities required to perform the [redacted] activities at San Tan include an electrical support system of 500 kVA which uses a 480/277 volt, three phase, four wire, grounded distribution system and one additional on-site 19,000 liter (5,000 gal) water storage tank to support test cooling and sanitation needs. The existing electrical support system consists of a 502 kVA, 3 phase, four wire, grounded distribution system while the existing water capacity consists of four tanks with a total capacity of 136,000 liters (36,000 gal) (Schultz, 1991). Although the additional water required in support of [redacted] activities requires only a 14 percent increase in on-site water capacity, the additional supporting electricity required would double the electrical infrastructure at San Tan. Because an additional electrical system would be required to avoid overloading the existing facilities for protracted periods and causing a reduction in service, the impact on infrastructure is anticipated to be moderate (and, therefore, potentially significant). The impact can be mitigated to insignificant levels by installing the line along existing corridors (i.e. existing roads and waterlines).

(U) Noise impacts as a result of [redacted] activities are anticipated to be high as they would exceed ambient noise levels by 35 dBA and may exceed OSHA limits for a short exposure. Since workers would wear appropriate hearing protection as necessary and the test area is remote from the nearest facility boundary, the environmental consequences are not considered significant. The cumulative noise impacts as a result of San Tan activities are anticipated to be negligible as the new HHGG facility is remote from the existing testing areas. Therefore, the environmental consequences from cumulative noise impacts would be insignificant.

(U) The operating conditions that would be achieved during the test activities are within the scope of routine operation at the San Tan facility. Large liquid hydrogen systems have been previously tested at this facility and are comparable to present work activities. There is a potentially significant safety issue regarding the release of hot hydrogen into the atmosphere and the potential impact of thermally induced turbulence effects on low flying small aircraft. GFSD has standard procedures to notify area pilots of the test schedule and exclude low flying aircraft over the site during test periods, thus effectively mitigating the significance of the impact.

(U) Waste materials generated at the San Tan facility as a result of [redacted] activities include cryogenic hydrogen and hydrogen rich steam burned at a rate of 57,000 liters (15,000 gal) in less than one hour through a flare stack. There are no regulated emissions or effluents as a result of testing and no water or air permits are required. Hazardous materials consisting primarily of liquid oxygen and liquid hydrogen would be transported in accordance with DOT regulations and handled and stored in accordance with DOD requirements. Test instructions for all [redacted] program operations would be written and approved by a Lab Safety Engineer and Division Safety Manager.

(U) Based on the Environmental Report prepared as a part of the lease transaction, the impacts to biological resources as a result of facility operation are anticipated to be negligible (GFSD, 1991). Approximately 0.4 hectares (1 acre) of land would be cleared of vegetation for construction activities. Aside from the few ground-dwelling animals which would lose burrows because of building pads and access roads, most wildlife would be unaffected by the facilities proposed for the 44 hectare (110 acre) site. Only the areas required for the few structures and access roads would be cleared of vegetation. The agreement with the Gila River Tribal Reservation Administration regarding the protection of certain plant species, including the saguaro cactus, would be strictly adhered to during all construction and operation activities. Buildings, roads and other construction would be located to avoid moving large saguaro cacti where possible. If it becomes necessary to remove a saguaro, it would be transported to a more appropriate location on site under the authority of the tribal administration. The lease agreement and permitting process protect native plant species. Buildings, roads and other construction would be located to avoid moving large saguaro cacti where possible. All native plant relocation would be under the permitting process and, as a result, no significant impacts to vegetation are expected. No significant impacts to cultural resources are expected.

(U) The environmental consequences of the [redacted] activities at San Tan are expected to be not significant based on the implementation of mitigation measures to infrastructure, noise, and safety, the conclusions of the Environmental Report which summarizes the impacts of

expanding the San Tan facility, and the commitment to transplant native plant species and the remoteness of the installation (GFSD, 1991).

<u>Activities at the Airesearch Los Angeles Division (ALAD)</u> (U)

(U) Development tests would be conducted in existing test cells located in the test laboratory of Airesearch Los Angeles Division (ALAD), Allied Signal in Torrance, California. Inert fluids would be used in place of cryogenic hydrogen. Waste materials as a result of these tests consist of approximately 37,000 liters (10,000 gal) of water or cryogenic nitrogen vaporized to a gaseous phase and exhausted into the atmosphere. Impacts are expected to be negligible. Therefore, environmental consequences of the [redacted] program activities at the ALAD facility are anticipated to be insignificant.

4.2.7 Grumman Space Electronics Division (U)

(U) All the activities that have and that would be performed at Grumman occur in existing laboratories. The Grumman testing includes simulation of instrumentation and controls using in-line equipment and are considered to negligible. Therefore, no significant environmental consequences at the Grumman facility are expected as a result of [redacted] program activities.

4.3 SADDLE MOUNTAIN TEST STATION (SMTS) - NEVADA TEST SITE (NTS) (U)

(U) This section discusses the expected environmental consequences of constructing and operating the proposed ground test facility at the SMTS at the NTS. The discussion includes potential non-radiological impacts as well as radiological impacts that result from routine operations and as a result of abnormal events or accidents.

([redacted]) Construction of new facilities would be phased to initially provide a sub-scale facility to accommodate PIPET and mini-GTA testing. The sub-scale facility would be expanded later to provide the full-scale facility necessary to complete the proposed activities in support of the [redacted] Program. These activities include the EIT, GTA and QTA testing. Impacts associated with both the sub-scale facility and the full-scale facility are described in the following sections.

4.3.1 Socioeconomics (U)

4.3.1.1 Population and Economy (U)

(U) Construction of the sub-scale and full-scale facilities at SMTS would each require an approximately eighteen month period with an average work force of 35 employees and a peak work force of about 100 employees. The test facility engineering and construction, and associated oversight activities, would be performed by existing personnel currently subcontracted at the Nevada Test Site. The hiring of a significant number of additional personnel is not anticipated. The construction activities are anticipated to have a negligible impact on either the population or the economy of the NTS and the surrounding area. Therefore, the environmental consequences would be insignificant.

(U) There would be a work force of no more than 60 technical, security and administrative personnel during the ground test operations. Hiring of additional personnel is not anticipated. The work force represents only 1 percent of the NTS labor force of 5,000. No additional demand would be placed on services and facilities. The impact of operations personnel on the population and economy would be negligible. Therefore, the environmental consequences would be insignificant.

4.3.1.2 Land Use and Infrastructure (U)

(U) Construction of the ground test facility would require approximately 40 hectares (100 acres) of land at the SMTS[1]. This is only 0.01 percent of the total land area of the NTS [350,000 hectares (875,000 acres)]. Chapter 2 describes the additional infrastructure required such as gravel roads, power lines, and phone lines. Construction of the SMTS would require connecting to existing roads, power lines and telephone lines.

([redacted]) There do not appear to be any significant issues concerning land use at the proposed site as the area is not currently used or occupied. The NTS is intended for nuclear testing so the

[1] (U) This includes land affected by the well as well as the water and power lines to the well.

proposed activity is consistent with the NTS's mission. There are no known mineral resources at the SMTS. The [redacted] program is not inconsistent with NTS, Nye County, or State of Nevada plans for that area. The SMTS is sufficiently removed from other testing areas to preclude interference with underground testing and other activities.

(U) Since the construction of the SMTS would be compatible with existing NTS land use, would cause only minor reductions in the supply of vacant land, and would have no noticeable effect on operating practices or require additional equipment or facilities, the impact of construction of the SMTS on land use and infrastructure would be negligible. Therefore, the environmental consequences would be insignificant.

(U) The potential impact of SMTS operations is assessed for the immediate area. A major accident could preclude the use of the immediate area for several days. However, there are no special use areas such as farmland, floodplains, and wetlands at the proposed testing location. The NTS is dedicated to nuclear testing. Since the operations at SMTS would not result in a change in land use, the impact of operations on land use would be negligible.

(U) Operation of the SMTS would not require additional facilities or equipment from the local infrastructure. Therefore, the operation of the ground test facility would have a negligible impact on infrastructure. Therefore, the environmental consequences would be insignificant.

4.3.1.3 Noise[2] (U)

(U) Construction equipment would increase noise levels at the SMTS. Large internal combustion engine-powered mobile construction equipment can cause sound pressure levels of 90 dBA or more at approximately 17 meters (50 feet). These noise levels could affect workers if protective measures are not implemented. Protective measures include following OSHA workplace noise regulation. (The actual noise limit varies depending on the total time of daily exposure. The limit for an 8 hour exposure is a time-weighted average of 90 dBA. The limit for 15 minutes or less is 115 dBA.) Noise caused by construction activities would be monitored by the REECo Industrial Safety Office and workers would be required to wear appropriate hearing protection as necessary.

(U) Non-project related personnel on NTS would not be affected by construction noise. They would be at least 10-12 kilometers (6-7 miles) away from testing activities.

(U) Areas outside the NTS are not likely to experience any noticeable increase in noise levels associated with construction because of the over 23 km (14 mi) distance from the SMTS site to the nearest NTS boundaries. Nearby communities would be out of range of the noise [at least 30 km (20 mi) away] such that sensitive receptors such hospitals, schools and residences would not be affected by the noise.

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[2](U) Noise effects on fauna are addressed in Section 4.3.3.

(U) Significant noise levels (>110 dBA) for short infrequent periods are expected to be associated with the ground testing activities. The noise would be generated on an intermittent basis during the scheduled operational testing sequence with a maximum of 10 to 12 tests operating for up to 1000 seconds each over a one year period. As with the noise generated by construction activities, only on-site personnel would be affected by the noise; during operations, all non-essential personnel would be excluded from the test site and stationed far enough away [5 km (3 mi)] to preclude adverse impacts. Appropriate protective measures would be used to lower the impact of testing noise on operating personnel. All essential personnel would be required to remain in the control bunker for safety purposes. While this structure provides a formidable barrier to sound penetration, protective devices would be available and used should the sound levels be above OSHA standards.

(U) Nearby communities would be out of range of the noise [at least 30 km (20 mi) away] and sensitive receptors within them would not be affected by noise levels due to operations.

(U) Construction noise would be raised above ambient levels (22-38 dBA) by more than the high significance criteria level of 35 dBA and could exceed the OSHA 8 hour long-term exposure limit (see Appendix D). In addition, noise from normal operations would be raised above ambient levels by more than the high significance criteria level of 35 dBA and could exceed the OSHA short-term exposure limit. Therefore, the impact of construction and operations activities on noise would be high and the environmental consequences could be potentially significant. However, because there are no sensitive receptors in proximity to the site and because hearing protection is required for operations personnel, the environmental consequences would be insignificant.

4.3.1.4 Historic and Archaeological Resources (U)

(U) Construction and operation of the proposed ground test facility would not impact sites listed in the National Register of Historic Places. Archaeological surveys of the proposed site including power line and access road routes as well as the water supply well have been conducted by the Desert Research Institute. The survey recorded and collected artifacts from five small sites along the proposed road segments, power line corridor, and in the center of the project area (SNL, 1990b). These sites are not eligible for the National Register of Historic Places. The sensitive area S103183MV14 identified during the 1983 DRI cultural resources survey located in the vicinity of the water-supply well would be flagged and left undisturbed. Because no resources possessing scientific or cultural significance are affected, the construction of the proposed test facility would have no adverse impact on historic properties. Concurrence from the State of Nevada Department of Conservation and Resources has been received (see Appendix F).

(U) Although detailed cultural surveys have not been performed for the power line and waterline leading to the water supply well, the probability of the existence of significant archeological or historical sites is considered low. There is a possibility, however, that some prehistoric cultural remains such as isolated artifacts and scattered stone chips and flakes may be encountered. The level of impact of these facilities on archeological and historic resources, therefore, is rated as low. This would be consistent with the findings of cultural resource surveys that have been

performed elsewhere in the Mid Valley area. Prior to any ground disturbance, detailed cultural resource surveys would be undertaken and, following consultation with the Nevada State Historic Preservation Office (SHPO), appropriate mitigation measures would be implemented prior to construction if these are required for SHPO concurrence. Mitigation measures would include 1) identification and recovery of artifacts, 2) re-routing of the power and water lines, and 3) flagging of sites to be left undisturbed. As a result of SHPO consultation and implementation of any required mitigation measures, impacts would be low. Therefore, the environmental consequences would be insignificant.

4.3.1.5 Safety (U)

(U) The design of the ground test facility has no unusual features that would increase worker hazards during construction. Mitigation includes ensuring that all construction activities would be carried out in compliance with all applicable regulations (i.e. OSHA, National Electric Code, National Fire Protection Code, DOE, etc). No additional occupational impacts beyond those currently experienced in construction at NTS are expected. Therefore, the impacts of construction on safety would be low and mitigable. (Radiological safety issues during construction are discussed in Section 4.3.4.1.)

(U) Operational safety issues include hydrogen, helium, and oxygen storage; Effluent Treatment System operation; seismic and volcanic events; and non-radiological accidents. (Radiological accident issues are addressed in Section 4.3.4.) Each safety issue is discussed below:

<u>Hydrogen Storage Safety</u> (U)

(U) There would be multiple hydrogen storage vessels at the ground test facility. Current plans for the sub-scale facility include approximately 420,000 liters (110,000 gal) of low pressure liquid hydrogen, 115,000 liters (30,000 gal) of high pressure liquid hydrogen, and 310 m^3, (11,000 ft^3) of high pressure ambient temperature hydrogen. Storage quantities could increase by a factor of two for the full-scale facility. If the ETS is cooled by cryogenic hydrogen the amount of hydrogen required would increase by an additional factor of two. All high pressure tanks would have 10-15 cm (4-6 in) thick steel walls which would provide significant protection from penetration by external projectiles (SNL, 1990a).

(U) Hydrogen is very reactive in an oxygen environment. The limiting oxygen index (the percentage by volume of oxygen required to propagate a flame) is very low, only five percent. Hydrogen may be ignited by sparks, open flames, or hot surfaces. A source of energy as low as human-induced static electricity may ignite the hydrogen. This is an order of magnitude less energy than is required to ignite other reactive materials such as methane and gasoline (McCarty, et al., 1981; Sax, 1984). Details of the hydrogen safety measures are discussed in Sections 2.3.2.2.1.3.1 and 2.4.3. (Safe design and safety procedures would be required as part of program policy. However, details of the design are not yet available).

(U) There are two main concerns associated with hydrogen storage: First is the failure to inert the system. If the hydrogen storage tanks are not purged of oxygen, deflagration and/or detonation could result. Second, is the possibility of leaks. Small leaks may occur around

piping connections and large leaks are possible during equipment failures. As the escaping hydrogen mixes with air the potential for deflagration and/or detonation would exist.

(U) The hydrogen system would be designed, operated, and maintained in accordance with all appropriate NFPA, CGA, and ASME standards to ensure sufficient protection for both personnel and on-site equipment. If a rupture should occur, only a portion of the theoretical maximum explosive potential would be available; a high energy explosion requires a well-mixed oxygen-hydrogen environment. Generally the proportion of combustible fuel in a spill is less than ten percent of the quantity spilled. Also, although gaseous hydrogen forms a combustible mixture very quickly, it is very buoyant, and the hazard exists for a relatively shorter time than, for example, a methane or gasoline spill (McCarty, et al., 1981). A shrapnel barrier system would also be in place to reduce the possibility that shrapnel, generated by a nearby explosion, would impact the hydrogen storage tanks. The shrapnel barrier would also serve to protect onsite personnel.

(U) The deflagration and/or detonation of hydrogen would cause a threat to the physical well-being of personnel on site. Therefore, the storage of a large amount of hydrogen at the ground test facility would have a moderate impact on safety, and the environmental consequences would be potentially significant. The potential significance, however, would be mitigated to insignificant levels by designing to strict accordance with the appropriate NFPA, CGA, and ASME standards.

<u>Helium Storage Safety</u> (U)

(U) Under current plans, approximately 135 m^3 (4,700 ft^3) of high-pressure helium would be stored at the sub-scale facility. Storage quantities could double for the full-scale facility testing. The rupture of one of the helium tanks would cause a sudden helium release. The released helium could displace oxygen and serve as an asphyxiant.

(U) Helium would be stored in accordance with accepted industrial practices, making the probability of a rupture very low. Because helium is very buoyant, the displacement of oxygen would be temporary. A shrapnel barrier system would also be in place to reduce the possibility that shrapnel, generated by a nearby deflagration and/or detonation, would impact the helium storage tanks. Because the storage of helium would expose the personnel to conditions that could threaten the well-being of personnel, helium storage would have a moderate impact on safety, and the environmental consequences would be potentially significant. The potential significance, however, would be mitigated to insignificant levels by designing to strict accordance with the appropriate NFPA, CGA, and ASME standards.

<u>Oxygen Storage Safety</u> (U)

(U) Approximately 19,000 liters (5,000 gal) of liquid oxygen would be stored onsite to be used in the Engine Integration Tests. Three potential dangers must be considered in relation to oxygen storage. First, leakage of the liquid oxygen may cause burns and tissue damage to the skin of exposed personnel. This is due to the extremely low temperature of liquid oxygen (Sax, 1984). Second, liquid oxygen is very combustible in the presence of readily oxidizable material.

It is very quickly absorbed by combustible materials including clothing and may quickly ignite (Kirk-Othmer, 1986). Leaks of oxygen are especially dangerous in the presence of a highly combustible material such as hydrogen, which would be stored onsite (NFPA, 1986; Sax, 1984). Third, when liquid oxygen vaporizes at standard atmospheric conditions, the gas would take up 860 times as much space as the liquid. Should this happen in an enclosed space, a high pressure explosion could result were the gas not vented (Kirk-Othmer, 1966).

(U) Although oxygen would be stored in accordance with accepted industrial practices, both the possibility of fire and the chance of oxygen burns would pose a threat to the physical well-being of personnel on site. The liquid oxygen storage would be separated from the hydrogen storage area (in accordance with the appropriate codes) to decrease the possibility of contact and potential deflagration and/or detonation should a leak occur. A shrapnel barrier system would also be in place to reduce the possibility that shrapnel, generated by a nearby deflagration and/or detonation, would impact the oxygen storage tanks (as well as to protect workers). The pipes carrying the cryogenic oxygen would also be insulated to prevent contact burns. Leaks of liquid oxygen are very easy to detect; the escaping cryogenic oxygen super cools water vapor to form ice in the leak area. Because of the possibility of fire and the chance for oxygen burns, the impact of the storage of liquid oxygen at the test facility would have a moderate impact on safety, and the environmental consequences would be potentially significant. The potential significance, however, would be mitigated to insignificant levels by designing to strict accordance with the appropriate NFPA, CGA, and ASME standards.

Effluent Treatment System Safety (U)

(U) During PIPET, mini-GTA and GTA-1, an Effluent Treatment System (ETS) would be used to treat the exhaust. A large amount of hydrogen [25-600 kg/sec (55-1320 lbs/sec)] would pass through the system and be flared in a stack (SNL, 1990a).

(U) There are three potential safety hazards associated with the ETS. (Note: Radiological issues associated with the operations of the ETS are addressed separately in Section 4.3.4.2.1.) First, air may enter the system, mix with hydrogen, and cause a deflagration and/or detonation. A hydrogen deflagration and/or detonation within or adjacent to the ETS may cause serious damage and loss of life. Second, leaks may develop, allowing hydrogen to escape into the atmosphere where ignition and subsequent deflagration and/or detonation could again occur. Third, the flare may extinguish causing a safety hazard as the unburned cryogenic hydrogen accumulates and creates an explosive atmosphere external to the system. (These safety considerations have been discussed above in the Hydrogen Storage Safety section.)

(U) As a safety measure, the ground test staff would be confined to the control bunker until completion of the test. Also, the flare would be equipped with a redundant propane pilot light to ensure that the hydrogen is combusted as it exits the flare.

(U) All of the safety issues associated with the ETS operation must be considered to pose a threat to the physical well-being of on-site personnel. Therefore, the operation of the ETS would have a moderate impact on safety, and the environmental consequences would be potentially significant. The potential significance, however, would be mitigated to insignificant

levels by strictly adhering to appropriate NFPA, CGA and ASME standards. Safety margins suitable for storing and distributing flammable fluids in manned areas will be induced in the design requirements and operational procedures would be reviewed by organizations with experience in managing large H_2 systems.

<u>Seismic and Volcanic Activity Safety</u> (U)

(U) The NTS is in a stable seismic zone classified as Seismic Zone 2 by the Uniform Building Code. Measurements taken during underground testing indicate that very little ground motion is transmitted to the proposed location of the SMTS. Were significant seismic activity to occur, buildings might collapse and leaks might occur in the hydrogen tanks or piping.

(U) The low probability of seismic activity would pose a slight but additional danger to onsite personnel. As a safety measure, the infrastructure at the test station would be designed to the requirements of Seismic Zone 4. The impact of seismic activity on safety would be low. Therefore, the environmental consequences would be insignificant.

(U) The NTS is not in an area of active volcanoes; the most recent volcanic activity occurred about 140,000 years ago. Potential hazards related to volcanic activities include the collapse of structures, the fouling of equipment, the blocking of access roads resulting from both volcanic ash deposition, lava flows and landslides. The probability of future volcanic activities of any type in the vicinity of the SMTS is so low (DOE, 1986) that it is not considered a potential hazard within the life of the proposed test facility. Since there is low probability that a volcano would occur during the life of the proposed action, personnel would be exposed to no more than baseline operating conditions. Volcanic activity would have a negligible impact on safety. Therefore, the environmental consequences would be insignificant.

<u>Non-Radiological Accident Safety - Beryllium Release</u> (U)

(U) The PIPET/mini-GTA and GTA/QTA assemblies contain beryllium (Be) metal which may become airborne in a catastrophic failure. Since oxidized respirable beryllium is a toxic material, its impact on the public must be considered.

([redacted]) The release data for determining Be inhalation was taken from SNL engineering estimates. The estimate of Be release is approximately 20 kg for PIPET/mini-GTA and 100 kg for the GTA/QTA test systems (Hipp, 1991). These amounts were assumed to be fully aerosolized given a catastrophic accident and subsequently dispersed into the resulting plume. An additional amount of Be (axial reflectors) could be dispersed during the accident but would be sufficiently removed from the heat source and is assumed to be distributed in large fragments within the immediate vicinity of the accident site.

(U) The subsequently dispersed Be is modeled using the MACCS plume release model. The MACCS code will output the time integrated concentration data as a function of distance. When multiplied by the source strength and the breathing rate, here assumed to be 3.47×10^{-4} m^3/sec, the total inhaled amount of Be can be determined as a function of distance. The peak

concentration of the Be cloud ($\mu g/m^3$) at the point of maximum inhalation can be estimated by dividing the total amount inhaled (μg) by the breathing rate (m^3/s) and the plume release time (S). This information is presented in Figure 4.3-1.

(U) Short-term inhalation exposures to levels of soluble Be compounds in excess of 100 $\mu g/m^3$ is reported to result in acute lung distress (Doull et al., 1980). OSHA has developed standards for the occupational exposure of workers to Be. These standards are as follows: 2 $\mu g/m^3$ 8 hour time weighted average (TWA); 5 $\mu g/m^3$ acceptable ceiling level; and 25 $\mu g/m^3$ for 30 minute maximum peak concentration. The OSHA maximum peak concentration of 25 $\mu g/m^3$ is derived by applying a safety factor of 4 to the 100 $\mu g/m^3$ value (USAF, 1987).

(U) For community air, a threshold of 0.01 μg Be/m^3 determined at breathing height averaged during a one month period is recommended (Clayton and Clayton, 1981). No stipulation is made as to peak concentration limit. However, this value is based on chronic exposure and is not a published criteria. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) is 2 $\mu g/m^3$.

(U) The most applicable criteria appears to be the OSHA maximum peak concentration of 25 $\mu g/m^3$ because this standard was developed to protect from acute effects of Be, which appears to most closely approximate conditions in the event of a catastrophic accident. The criteria of 25 $\mu g/m^3$ already incorporates a safety factor of 4 and appears to be protective of acute effects of Be; therefore, this appears to be a reasonable criteria to protect public health from acute effects. Be concentrations in excess of 100 $\mu g/m^3$ should be a cause for immediate concern.

([redacted]) The GTA/QTA release results in a maximum total inhalation of approximately 0.067 $\mu g/m^3$ which is well under the 20 $\mu g/m^3$ limit (exposure to 2 $\mu g/m^3$ during an 8 hour period) established by OSHA. Furthermore, a maximum concentration of 3 $\mu g/m^3$ is calculated for the GTA/QTA accident release, which is less than the OSHA peak concentration limit of 25 $\mu g/m^3$. As shown in Figure 4.3-1, Be exposures from the postulated PIPET/mini-GTA accident are over five times less.

(U) Since a non-radiological accident would introduce beryllium at levels below standards and not affect humans, the impact of a non-radiological accident on safety would be negligible. Therefore, the environmental consequences would be insignificant.

<u>Synopsis</u> (U)

(U) In general, the activities taking place at the SMTS would have a moderate impact on safety. Therefore, the environmental consequences would be potentially significant. The potential significance, however, would be mitigated to insignificant levels by implementation of the mitigation measures discussed above. Because the site is far removed from the general public, there would be no effects to public health and safety.

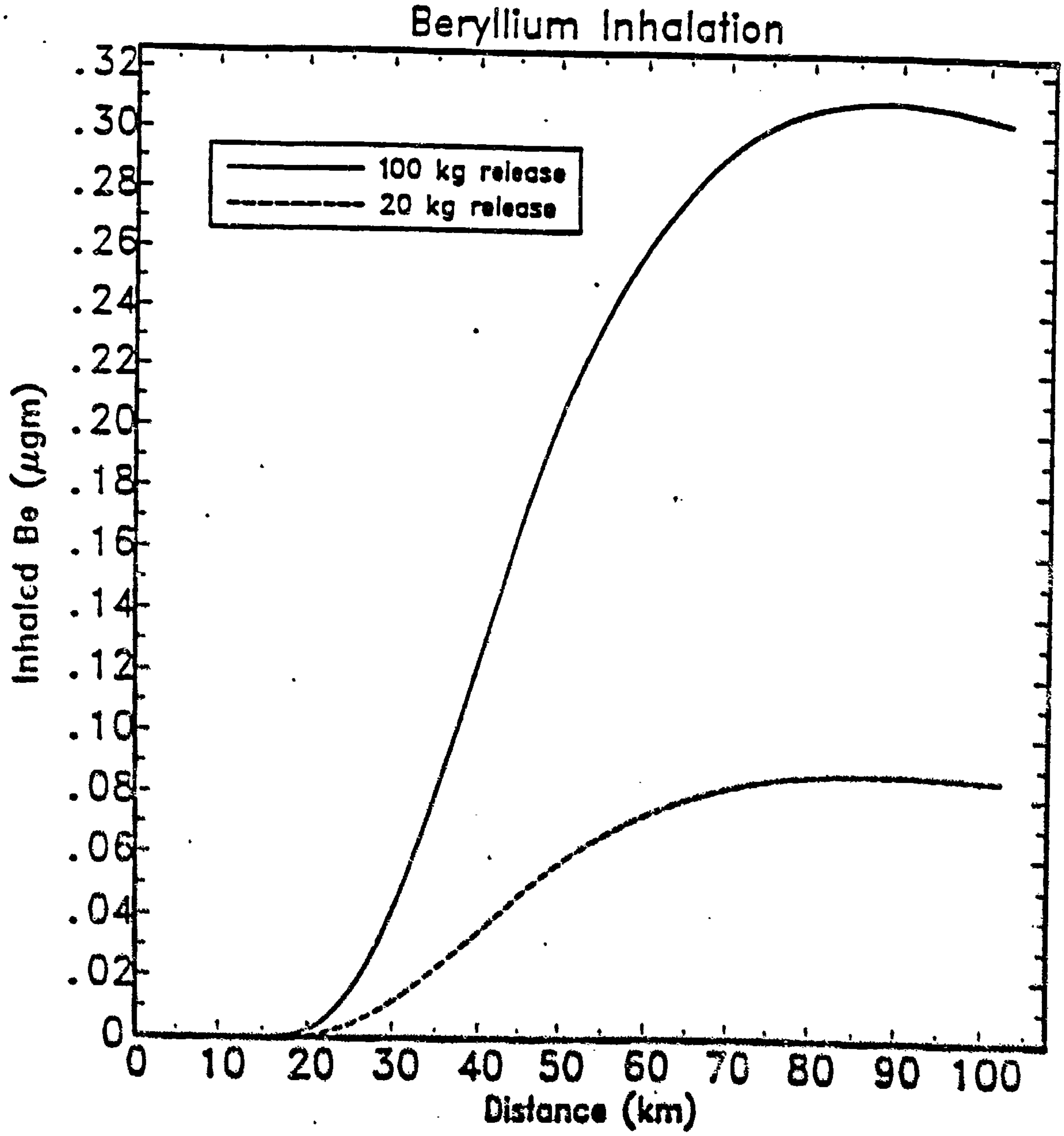
Beryllium Inhalation
100 kg release
20 kg release
Inhaled Be (μgm)
.32
.30
.28
.26
.24
.22
.20
.18
.16
.14
.12
.10
.08
.06
.04
.02
0
0 10 20 30 40 50 60 70 80 90 100
Distance (km)

Figure 4.3-1 (U)

4.3.1.6 Waste (U)

(U) Operations at the ground test facility would generate radioactive and hazardous wastes. These wastes are described below[3]:

Radioactive Waste (U)

(U) All radioactive waste materials generated at the NTS during SMTS activities are classified as defense wastes, which would be managed in accordance with DOE Order 5820.2A (Radioactive Waste Management). The radioactive waste most likely to be generated would be low-level waste (LLW), low-level mixed waste (MW), and potentially some transuranic (TRU) waste. Each type of radioactive waste and its impact on waste management is described below:

(U) High-Level Radioactive Solid Waste: It is currently anticipated that with the relatively short operating times, the fuel material would not contain any transuranic material in excess of 100 nCi/g and the resultant material would be certified as fissionable test specimens. Any associated waste products would be disposed of as LLW. The only material anticipated to be generated in association with the SMTS activities which would be certified as HLW would be in the form of spent reactor fuel. Should this occur, the HLW would be isolated at the ground test station pending final disposition which would be accomplished in accordance with the defense HLW program procedures. The impact of HLW on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Transuranic Waste: SMTS activities at the NTS are not expected to generate any transuranic waste material (elements with atomic numbers higher than 92). The only waste material which could potentially be certified as TRU would be the irradiated fuel material should the concentration of TRU exceed 100 nCi/g. For analytical purposes, the amount of TRU waste material generated is assumed to be 30 m^3 (1,000 ft^3), a default quantity which relates to the amount of material in a single TRUPAC-II shipment from the Nevada Test Site near Las Vegas, Nevada, to the Waste Isolation Pilot Project (WIPP) located near Carlsbad, New Mexico.

(U) Onsite generated wastes properly certified as TRU would be packaged and stored at the NTS pending later shipment to either WIPP or another designated facility capable of providing permanent disposal for TRU wastes.

([redacted]) The default value of 30 m^3 (1,000 ft^3) of TRU wastes would require only 3 percent of the remaining 1,000 m3 (35,000 ft^3) storage capacity at the NTS and would increase by less than 5 percent the total quantity of TRU currently stored or forecast for the installation through the year 2013. The single additional shipment required by the 30 m^3 of TRU waste assumed to be generated by the [redacted] Program increases the total number of shipments analyzed by the WIPP FEIS (DOE, 1980) by approximately 1 percent and does not impact the consequences nor the mitigation measures presented in that document. Since the handling of any program generated TRU wastes would cause no changes to the existing operational arrangements at the NTS and represents only a very small portion of the NTS TRU waste shipment and disposal activities as

[3](U) A programmatic discussion of waste issues is presented in Section 2.4.1.

analyzed in the WIPP FEIS (DOE, 1980), the impact of program generated TRU wastes on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Low-Level Radioactive Solid Waste: It is anticipated that the low-level radioactive solid waste generated at the SMTS would be on the order of 46,000 m^3 (1,600,000 ft^3) over the life of the project. LLW requiring disposal would consist of solid wastes from the handling, cleaning and disassembling of the canister assemblies as well as contaminants removed directly from the effluent stream. This material would be placed in shallow land disposal at the appropriate NTS facilities.

(U) In addition, the irradiated fuels and irradiated test samples would be disposed of as LLW provided that these materials are determined by DOE to be low-level wastes. These wastes would be appropriately packaged, nondestructively assayed, and disposed of at one of the existing Radioactive Waste Management Sites (RWMS) located in Area 5 of the NTS. Approximately 150,000 m^3 (5,200,000 ft^3) of LLW is presently buried in the RWMS (DOE, 1991).

(U) NTS presently has a remaining capacity of 500,000 m^3 (18,000,000 ft^3) for solid low-level radioactive waste with an anticipated annual input of 25,000 m^3 (18,000,000 ft^3). At the end of the 10 year life of the [redacted] Program, the remaining capacity at NTS would be 250,000 m^3 (9,000,000 ft^3). The amount of solid LLW anticipated to be produced by the program would represent 18 percent of this remaining capacity. However, NTS is continually updating its solid LLW storage and disposal capacity requirements. Expansion of waste storage and disposal facilities is an ongoing process to meet the waste management mission of disposing of all waste. Since the solid LLW generated would cause no changes in operational arrangement, the impact of solid LLW on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Mixed Waste: Some mixed waste may be generated during program activities. This would include low-level radioactive materials contaminated by solvents or solvent residues. It is anticipated that no more than 0.2 m^3 (7 ft^3) or that material that could be contained in a single 55 gallon drum (210 liters) would be produced by program activities.

(U) Mixed wastes would be contained at their point of generation and characterized, for eventual compliance with Land Disposal Restrictions (LDR), and the installation waste disposal requirements. Full containers would be accumulated for less than 90 days, then transported to a mixed waste (RCRA) disposal area at the Area 5 RWMS (DOE, 1990c). Mixed wastes must meet Land Disposal Restriction (LDR) requirements prior to disposal. Every effort would be made to minimize or totally eliminate quantities of mixed wastes generated by the SMTS projects.

([redacted]) NTS presently has a remaining capacity of 144,000 m^3 (5,000,000 ft^3) for mixed radioactive waste (DOE, 1990c) with an anticipated annual input of 20,000 m^3 (700,000 ft^3). The maximum anticipated input of mixed wastes [0.2 m^3 (7 ft^3)] is only 0.001 percent of the anticipated annual mixed waste input at NTS.

(U) Because the quantity of mixed wastes generated would be small, the impact of mixed waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

Hazardous Waste (U)

(U) The quantities of hazardous non-radioactive waste material anticipated to be generated during the ground testing activities are estimated to be approximately 15 m^3 (500 ft^3). These include limited quantities of solvents and materials such as gloves, paper, and cloth that contain absorbed solvents. Generation of hazardous waste would be minimized by controlling the quality of solvent materials used in association with all activities at SMTS.

(U) Hazardous wastes generated as a result of operations would be managed by Reynolds Electrical and Engineering Co., Inc. (REECo) in accordance with the Resource Conservation and Recovery Act (RCRA) Part B, Permit Application for Generation of Hazardous Waste and Mixed Waste Disposal (NV 389 009001) (DOE, 1990d). These wastes are collected at the local testing facility up to a specified limit of 210 liters (55 gal) per waste stream and then transferred to the Area 5 Hazardous Waste Accumulation Pad for ultimate disposal at an EPA-approved off-site treatment, storage, and disposal facility prior to the end of the 90 day storage limit. All EPA and DOT regulations (i.e. 40 CFR 262-263 and 49 CFR 100-199) for the handling, sampling, manifesting, packaging, and shipment preparation of hazardous wastes would be followed.

(U) Since the quantities of hazardous waste are projected to be low and would cause no changes in operational arrangements, the impact of hazardous waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

Non-Hazardous Waste (U)

(U) Two types of non-hazardous waste are anticipated to be produced at the NTS from [redacted] Program activities: sanitary liquid waste and solid waste. These are described below:

(U) Sanitary Liquid Waste: It is anticipated that 18,000 m^3 (640,000 ft^3) [18 million liters (5 million gallons] of sanitary waste would be produced by construction and operation activities at SMTS. The quantities of sanitary effluents associated with the work crew are small when compared to those for all the other construction activities at NTS as a whole.

(U) Some additional collection and disposal facilities would be required such as the installation of temporary sanitary facilities. However, this is standard practice for construction activities at NTS. Operations of the SMTS would require the installation of a septic tank and leach field. This is standard practice for NTS facilities outside the reach of existing sewage facilities. Because the septic system is anticipated to handle less than 19,000 liters per day (5,000 gal/day) with no industrial waste as part of it, only review by the Nevada Department of Consumer Health is required.

(U) Because the generation of sanitary liquid waste would not require changes in existing operational arrangements, the impact of sanitary waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Solid Waste: It is anticipated that 4,000 m^3 (140,000 ft^3) of non-hazardous, non-radioactive solid waste would be produced at the NTS by the [redacted] program. Because the generation of solid waste would not require changes in existing operational arrangements, the impact of solid waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

([redacted]) In general, [redacted] program activities taking place at NTS would have a negligible impact on NTS waste management. Also, because no new waste sites would be needed, there would be no increased risk to the workers or the environment. Since the wastes generated by the [redacted] program would be managed in accordance with existing waste management procedures which include protection of the environment, the environmental consequences would be insignificant.

4.3.2 Physical Environment (U)

4.3.2.1 Topography (U)

(U) Construction of the ground test facility would require no more than 40 hectares (100 acres) of land east of Shoshone Mountain within Area 14 of the NTS. The cut and fill required for the proposed construction are approximately 28,000 m^3 (37,000 yd^3) and 20,000 m^3 (26,000 yd^3) respectively although the numbers are subject to modification (SNL, 1990a). The borrow area that would be used for fill material is located on the NTS. For road construction, excavated material would either be deposited on the downhill side or utilized for fill within the test facility.

(U) There could be alterations of the natural surface drainage as a result of grading within the SMTS. Grading activities would include all surveying, cleaning, grubbing, and compacting specified for the SMTS facility. Culverts would be designed into the surface drainage system for ramps and road crossings. Runoff from heavy precipitation might fill adjacent dry washes, but would not flood the facility because of its location on a ridge and design against flooding of operational facilities.

(U) Because the SMTS would be built in compatibility with existing contours and because the station's size would be minimized where possible and because little change would be made to the character of the area, the impact of the construction of the SMTS on topography would be negligible. There would be no impact on topography from operations. Therefore, the environmental consequences would be insignificant.

4.3.2.2 Geology and Soils (U)

(U) The only geological effects of the SMTS facility are to the soils. Construction would cause leveling and/or resurfacing of the soils in the affected area. Dust and soil would be transported

by winds during construction activities. It is expected, however, that this effect would be local and temporary. The removal of vegetation from the construction area should not significantly increase soil erosion from rainfall since the vegetation is sparse and the ground surface is predominantly gravel. Protection against erosion includes 1) the orientation of the facility parallel to the natural surface features to minimize water induced erosion, 2) the orientation of the facility to minimize wind-induced erosion, and 3) the application of spray mist water to minimize wind-caused soil erosion.

(U) There would be no known effects upon paleontological or mineral resources, agricultural soils or construction materials at the SMTS. Because construction and operation would cause no loss of geologic or soils resources in the area, the project would have a negligible impact on geology. Therefore, the environmental consequences would be insignificant.

4.3.2.3 Seismic and Volcanic Activity (U)

(U) Because construction and operations would not cause seismic and volcanic activity that would be noticeable to instrumentation or humans, the project would cause negligible impacts to seismic or volcanic activity. Therefore, the environmental consequences would be insignificant.

4.3.2.4 Water Resources (U)

(U) There are no surface water resources in the vicinity of the SMTS that would be affected by activities at SMTS (Tonopah Spring and Yucca Flats Lake are both too distant and too ephemeral to be considered as regional water resources). The water table in the area of the ground test facility is over 500 m (approx 1,650 ft) below the earth's surface in tuffaceous aquifers. Ground water may be affected by events which take place at the surface. In particular, two issues must be considered: water use and water quality.

Water Use (U)

(U) During construction, an estimated 60 million liters (16 million gal) of ground water would be withdrawn for potable water and construction use. During operations, an estimated 11 million liters (3 million gal) of ground water would be withdrawn per year. This would not cause a measurable drawdown of the existing water table. (There has been no observable drawdown of the Ash Meadow Sub-basin from other NTS activities.) Because water use would cause no measurable change in the water resource system, the impacts of water use on water resources would be negligible. Therefore, the environmental consequences would be insignificant.

Water Quality (U)

(U) Approximately 1,900,000 liters (500,000 gal) of water would be stored onsite for multiple purposes. This stored water would produce adverse environmental effects only if the storage tanks leak or fail, or water is used to fight a fire. Were this to occur, water might temporarily inundate the area and pick up ground pollutants such as oil from the roads, or other

hydrocarbons such as gasoline. It is unlikely that any pollutants dissolved in the water would percolate through the 100 year to 3 million year journey to the ground water table.

(U) Domestic waste water products (sanitary sewage) would be collected in sewer lines and delivered to a septic tank and subsequently to a leach field. The system would be designed to dispose of waste water by evaporation and percolation into the soil. The ground water is of sufficient depth to minimize the possibility of adversely affecting the groundwater quality. [Other waste water (i.e. from the receiving/assembly and disassembly buildings, etc) would be collected and disposed of as hazardous waste.]

(U) Other potential impacts on water resources include spills of oil (or other substances) which could eventually percolate to the ground water table. Mitigation includes taking precautions when handling fuel supplies as well as the implementation of a readiness plan to recover spills.

(U) Because there are no surface waters in the area that would be affected by the project, the small likelihood of a spill, and the depth of the water table, the waste water produced by operations at the site would have a negligible impact to water quality. Therefore, the environmental consequences would be insignificant.

<u>Synopsis</u> (U)

(U) The use of water and the discharge of waste water would have a negligible impact on water resources. Because impacts would be negligible, and testing operations are of short duration (approximately four to ten years), environmental consequences would be insignificant.

4.3.2.5 Meteorology and Air Quality (U)

(U) There would be no impacts on meteorology as a result of construction and operation of the ground test facility.

(U) Air quality issues associated with the construction and operation of NTS include dust, engine emissions, process fluids releases, ETS releases, and hot hydrogen venting. Each are discussed below:

<u>Dust</u> (U)

(U) During construction, airborne dust would occur from the movement of vehicles and machinery and from excavation by heavy equipment. These dust emissions would continue throughout the construction phase but would be expected to have no significant effect on areas outside of the NTS. After construction, dust would be produced by the movement of vehicles at and around the ground test facility. The quality of dust generated would depend on soil moisture and the level of activity at the site. Water, oil or other dust suppressants would be applied to the loop road as mitigation.

(U) The effects from dust would be local and temporary, subsiding after cessation of construction activities. Because the dust that would result from project activities would not equal

or exceed EPA minimum standards (150 $\mu g/m^3$ for 24 hour average), dust from the project would have a negligible impact on air quality. Therefore, the environmental consequences would be insignificant.

Engine Emissions (U)

(U) The construction and operation of the test cells and support facilities would require the use of internal combustion powered heavy equipment. The amount of the emissions would depend on the duration of the equipment operation, types and numbers of vehicle engines and the climatic conditions such as temperature, wind speed, wind direction, precipitation and soil moisture. Any generator that is greater than 250 hp or anticipated to be used for greater than 100 hours per year would require a State of Nevada permit. In addition, commuter traffic would add to the project emissions. Pollutants associated with the operation of engines include carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), ozone and hydrocarbons.

(U) The total quantity of the pollutants generated by engine emissions cannot be predicted precisely because total equipment and equipment use time is not established. However, the emissions generated by the construction of a facility of similar size may be used as an indicator of engine emissions for the construction of this project. The construction of the Special Isotope Separation Project (SIS) is representative of the scale of activities required to construct the SMTS [25 hectares (60 acres) impacted and a workforce of approximately 800]. DOE forecasted that the construction of the SIS would generate 4.1 metric tons (4.5 tons) of NO_x, 57.8 metric tons (63.0 tons) of CO, and 2.3 metric tons (2.5 tons) of hydrocarbons (DOE, 1988a). Each of these criteria pollutants are under the federal Prevention of Significant Deterioration (PSD) permitting standards of 230 metric tons/year (250 tons/yr). These quantities are also below Nevada's standard of 100 tons/yr.

(U) There is no comparable operation from which to derive engine emissions. However, 100 tons/yr of emissions is generated from an output of approximately 34,700 horse power (based on 240 hr/yr operation). This converts to an electrical output of approximately 11,700 kw. Anticipated testing at the ground test station would be well within this power requirement and would thus not exceed standards.

(U) In as much as engine emissions would be widely dispersed in a relatively isolated and remote area of the NTS, and because the emissions do not equal or exceed standards, the impact of engine emissions on air quality would be negligible. Therefore, the environmental consequences would be insignificant.

Process Fluids Releases (U)

(U) Hydrogen, helium and oxygen would all be stored in bulk quantity at the test facility. During filling and purging of the storage vessels, some leakage may occur. Also, helium may be released to the atmosphere following its use as a purging agent. Because the releases would occur outdoors, any liquids (which would quickly vaporize) and gases would disperse quickly. There are no state or federal standards governing emissions of any of these substances. The

gases and H_2O are principle constituents of unpolluted air and are not considered pollutants. Leakage of these process fluids would not degrade air quality.

(U) Since the release of process fluids may be considered environmentally benign and since there are no EPA standards for the release of these substances, the impacts of process fluids and gaseous releases on air quality would be negligible. Therefore, the environmental consequences would be insignificant.

ETS Releases (U)

(U) The primary environmental impact associated with ETS releases would be the flaring of hydrogen. Although flare temperatures can be expected to exceed 810 K (540° C) and rise to a height of several hundred feet, the release of hydrogen to the environment is not regulated by the EPA and the effects of thermal heating would be local and temporary. As a result, ETS releases are expected to have a negligible impact on air quality. Therefore, the environmental consequences would be insignificant.

Hot Hydrogen Venting (U)

([redacted]) [redacted].

(U) The release of hot hydrogen would cause thermal heating. As with the ETS releases of hydrogen, the effects of thermal heating would be local and temporary and would not violate EPA standards. Therefore, the impact of hot hydrogen releases on air quality would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

(U) In general, the activities at the SMTS would have a negligible impact on meteorology and air quality. Since the emissions would be well below the threshold values and the emissions standards that protect human health and welfare, the environmental consequences would be insignificant.

4.3.3 Biological Resources (U)

4.3.3.1 Terrestrial Biota (U)

(U) The construction of the ground test facility would result in the loss of approximately 40 hectares (100 acres) of land from the Transitional Desert Association habitat. An area of 2 hectares (4 acres) surrounding the test facility fence would have all vegetation removed to act as a fire break. Brush fires are a major risk at NTS and have accounted for plant cover modification of sizeable areas (EG&G, 1988). Impacts on biological resources would result from the facility construction including loss of habitats, destruction of vegetation, loss of wildlife and disruption of migration and breeding patterns. Wildlife in the immediate area would be

forced to relocate (SNL, 1990b). The Nevada Department of Forestry plans to remove an estimated 312 individuals of Yucca brevifolia and 10 individuals of Yucca schidigera, prior to construction activities for use in landscaping public facilities in southern Nevada and the NTS.

(U) Although biological surveys have not been performed for the power and water lines to the water-supply well, the probability of the occurrence of sensitive species is considered low; the impact of these facilities on biological resources, therefore, is rated as low. Prior to construction activities, a biological resources survey would be performed and, if threatened or endangered species are identified, consultation with the U.S. Fish and Wildlife Service (FWS) would take place. Mitigation measures such as re-routing the proposed waterline and power line to the water-supply well would be undertaken to ensure that the environmental consequences would be insignificant.

(U) There are three potential operational activities that may impact terrestrial organisms. These are noise, hot-hydrogen venting, hydrogen flaring, and steam releases. Each are discussed below: (A description of radiological impacts to terrestrial biota is provided in Section 4.3.4.2.1).

Noise (U)

(U) Noise from the ground tests are expected to be greater than 110 dBA and would effect the nearby animal populations, principally birds (such as the black throated sparrow (Amphispiza bilineata) and the Le Conte's thrasher (Toxostoma lecontei). Birds would be temporarily frightened off but are expected to return upon completion of each test. The noise from the tests would actually provide a benefit by scaring away birds that might otherwise fly near the hot-hydrogen emissions or over the hydrogen flare stack. Other terrestrial biota, such as rodents, would also be frightened off by the noise of the tests. Because habitat quality and diversity are low and the duration of the noise short, the impact of noise on terrestrial biota would be negligible. Therefore, the environmental consequences would be insignificant.

Flaring of Hydrogen from ETS (U)

(U) As described in Section 4.3.2.5, the flaring of hydrogen from the ETS would cause thermal heating of approximately 810 K (540° C) to a height of several hundred feet. The total anticipated release over the 5 year period of tests is approximately 15 million kg (7 million lbs) of hydrogen (SNL, 1990a). The flare may pose a danger to birds which may venture near it. The probability of a bird flying into the hydrogen flare depends on the simultaneous occurrence of two low probability events: 1) the probability of flaring occurring and 2) the probability of the bird being in the low elevation hot-hydrogen vent danger zone. Because of the low quality and diversity of the habitat and the low probability of birds being in the flare zone while the flare is in operation, the impact of the flaring of hydrogen on terrestrial biota would be negligible. Therefore, the environmental consequences would be insignificant.

[redacted]

Hot Hydrogen Venting (U)

([redacted]) As described in Section 4.3.1.2.5, for ground tests which do not utilize an ETS, hot hydrogen would be vented from the test articles without passing first through the ETS. The plume could extend several hundred feet. [redacted].

(U) The hot hydrogen would cause thermal heating that may impact nearby vegetation and local bird populations that may be in the area. However, most vegetation would have been cleared from the area as a fire-break and security zone prior to the commencement of ground tests. As described above the probability of birds or other biota being in the area during ground testing operations would be very low.

(U) Because of the low quality and diversity of the habitat, the low probability of animals being near the test area at the time of testing, and the previous clearing of vegetation, the level of significance of hot-hydrogen venting on terrestrial biota would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

(U) In general, the activities at the SMTS would have a negligible impact on terrestrial biota. However, there is a low probability that some sensitive species could be affected. Therefore, the overall impacts on terrestrial biota is considered low and the environmental consequences would be insignificant.

4.3.3.2 Aquatic Biota (U)

(U) Some waterfowl may be in the vicinity of the SMTS if precipitation has caused the temporary formation of Yucca Flats Lake. Because there is a low likelihood that the lake would exist during testing, and because there is little chance that waterfowl would be in the lake given that it did exist and because of the great distance from the lake to the test station [13 km (8 miles)], and because the lake would not support a high quality habitat, construction and operations would have a negligible impact on aquatic biota. Therefore, the environmental consequences would be insignificant.

4.3.3.3 Threatened and Endangered Species (U)

(U) Based on the pre-activity survey of the SMTS and its new power line route, no threatened or endangered species, or their habitat, are known to occur in the vicinity of the SMTS. The desert tortoise (Gopherus agassizii), a threatened species as of April 1990, is not known to inhabit the proposed test location. Additional documentation has identified the Desert Tortoise range as located south of the SMTS. Therefore, ground testing activities at SMTS would cause no impacts to threatened and endangered species. Therefore, the environmental consequences would be insignificant. (See Appendix F for consultation.)

[redacted]

(U) A pre-activity biological resources survey of the power and waterline routes leading to the water supply well would be performed prior to any construction activities in those areas. The routes would be modified to avoid any impacts to threatened or endangered species that are identified during this survey following consultation with the FWS.

Synopsis of Biological Resources (U)

(U) Although the impact of noise, flaring, and hot-hydrogen releases would be negligible, there is a probability that some sensitive species could be affected. Therefore, the overall impacts on terrestrial biota is considered low and the environmental consequences would be insignificant.

4.3.4 Radiological Impacts (U)

4.3.4.1 Radiological Impacts During Construction (U)

(U) Prior to construction, radiological monitoring as required by DOE Order 5400.1 would be performed at the proposed SMTS to ensure no more than background soil contamination exists in the areas to be disturbed. If radiological contamination in excess of these levels are found, the area would be remediated to acceptable levels before construction begins. Dust control techniques would be used as appropriate, and any contamination present would be dispersed or settle out before it reaches the NTS site boundary. Offsite exposures from construction activities would, therefore, be negligible.

4.3.4.2 Radiological Impacts During Operations (U)

4.3.4.2.1 Normal Operations (U)

(U) The projected radiological impacts associated with the normal operations at the SMTS would result from (1) periodic atmospheric releases during the PIPET, mini-GTA, GTA and QTA tests, and (2) incremental releases and exposures attributable to the handling and transporting of the reactor core and radioactively contaminated solid or liquid wastes. These operational releases are based upon the activities discussed in Section 2.3.3. The following sections discuss each of these areas.

<u>Atmospheric Emissions</u> (U)

(U) During the test operations, small amounts of radioactive material would be released to the atmosphere. Releases could include primarily noble gases but small quantities of halogens, volatile fission products and particulates could also be expected. The fission product inventory anticipated to be available for release during operational testing are given in Appendix A.

([redacted]) The fission product inventory would be dependent on the power levels generated during the test and the length of time of the test (i.e., higher power levels and longer run times increase the fission product inventory). In this analysis for normal operations, the following run parameters were assumed: PIPET and Mini-GTA - 550 MW for 500 seconds and, GTA and QTA - 2000 MW for 1000 seconds. The resultant system source term would then be dependent on the core release fractions and the effectiveness of the effluent treatment system.

(U) The radiological impacts for routine operations were modeled assuming that operational releases for the tests would be a plume emitted through the flare stack. "Program model conditions" were created to represent the expected physical parameters associated with testing activities. These conditions are described in the following paragraphs.

([redacted]) The normal operational plume power for the PIPET and mini-GTA was calculated to be 605 Megawatts (MW), while the plume power for the GTA and QTA was calculated to be 3,025 MW. Release times for the flared plume were assumed to be equal to operational test times. Release fractions from the reactor core for all operational releases were assumed to be 8×10^{3}

for noble gases, 5×10^2 for halogens and volatiles, and 4×10^3 for particulates. All releases were based on the design criteria that the ETS remove 99.9% of the particulates and volatiles and 99.5% of the halogens and noble gases. [Similar efficiencies were demonstrated in the NERVA tests (USAEC/NASA, 1971)]. Design capability would be confirmed by preoperational tests. The radioactive gases would be retained in the ETS. (For example, they might be transferred to a compressed gas cylinder for a short period of time prior to release, to allow decay of the radioisotopes.) A decay time of one day was assumed in this assessment. Environmental impact of controlled release of this material is included in the impact assessment.

(U) Based upon the statistical average of meteorological data obtained from a sampling station in the vicinity of proposed operations, a wind velocity of 5.5 m/s (18 ft/s) and a Pasquill Stability Class D[1], were selected as representative of typical existing conditions. Iterative computer analysis, when evaluated against published historical meteorological information, demonstrated that an assumed inversion layer height of 2000 m (660 ft) resulted in compliance with applicable NESHAPs limits and occurred with sufficient frequency that it could be reasonably expected to accommodate operational requirements.

(U) Based on the fission product inventory, exposure pathways analysis, and risk assessments appearing in Appendix A, radiological dose was calculated as a function of downwind distance, and the result was used to estimate the dose to the maximally exposed offsite individual[2], assumed to be at least 23 kilometers (14 mi) downwind, corresponding to the nearest NTS boundary. Population dose was calculated for each wind direction downwind for a distance of 80 km (50 mi). The radiological doses were calculated using MACCS, a computer code system for calculation of reactor accident consequences, developed by Sandia National Laboratories.

(U) The radiological doses presented in this Environmental Impact Statement (EIS) are expressed as 50 year committed effective dose equivalents (CEDE), the sum of the external doses received from cloudshine and groundshine and the internal doses received from inhalation and during plume passage and resuspension inhalation integrated over a 50 year period. Population doses also include the dose from ingestion of contaminated food and water. Virtually all the committed dose would be received in the first year following the radiological release.

(U) The Environmental Protection Agency (EPA) provides guidance required on offsite dispersion and consequence modeling in 40 CFR Part 61, Subpart H, EPA Regulations on National Emission Standards for Hazardous Air Pollutants (NESHAP). That guidance is incorporated in DOE Order 5400.5, Radiation Protection of the Public and the Environment for modeling offsite doses to the public. DOE Order 5400.5 states: "Analytical models used for dose evaluations shall be appropriate for characteristics of emissions ... mode of release (e.g., stack or vent; crib or pond; surface water or sewer; continuous or intermittent)." In addition, the order states: "Dose evaluation models that are codified, approved, or accepted by regulatory

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[1](U) A Pasquill stability classes (also termed atmospheric stability classes) are measures of relative turbulence. There are six categories of stability classes, A through F: A (extremely unstable), B moderately unstable), C (slightly unstable), D (neutral), E (slightly stable), and F (moderately stable).

[2](U) Radiological effects on flora and fauna are addressed later in this section.

and other authorities shall be used where appropriate, such as the AIRDOS/RADRISK codes for demonstrating compliance with 40 CFR Part 61, Subpart H."

(U) As required by NESHAPS, appropriate regulatory permit modeling would be performed as specified in 40 CFR 61.

([redacted]) The [redacted] reactors are anticipated to be intermittently operated for relatively short durations only. This mode of operation is more typical of accidental releases of short duration. It was, therefore, determined that the operational releases from the SMTS would be better modeled with the MACCS code, which was designed for accident consequence analysis for nuclear reactors, instead of AIRDOS, which was designed for chronic releases over a 1 year period or longer. To convert doses, which are expressed in terms of rem and person-rem, to health effects (i.e. the risk of latent cancer fatalities and genetic disorders), the doses were multiplied by risk model factors recommended by BEIR V (BEIR, 1990).

(U) The BEIR V report is the fifth in a series of National Research Council committee reports on the biological effects of ionizing radiation (BEIR, 1990). The DOE is evaluating this report and its implications for DOE operations and standards; similar evaluations are being performed by national and international radiation protection organizations. The mean value given by the BEIR V committee for increased cancer fatalities resulting from an acute whole-body dose of 10 rem to 100,000 individuals (that is, 1,000,000 person-rem) is about 795 fatalities (760 for males and 810 for females), or about 7.9 X 10^{-4} cancer fatality/person-rem. This value is used in this EIS. The BEIR V report also indicates that "for low LET (linear energy transfer) radiation, accumulation of the same dose over weeks or months, however, is expected to reduce the lifetime risk appreciably, possibly by a factor of 2 or more."

(U) The BEIR V estimate of total genetic risk at equilibrium is 100-200 additional cases/million live births/rem/generation. This is roughly 1-2 x 10^{-4} genetic effect/person-rem/generation. The factor used in this EIS is 2.6 x 10^{-4} genetic effect/person-rem for all generations. As stated by the BEIR V committee, the genetic risk factors are highly uncertain, and the committee recommends that further studies be conducted.

(U) Appendix A provides a more detailed discussion of the methods used to calculate routine onsite radiological doses and consequences due to radiation emissions.

Maximum Offsite Individual Dose (U)

(U) The committed effective dose equivalent (CEDE) and maximum committed organ doses received by a hypothetical person residing at the location of maximum dose near the SMTS are summarized in Table 4.3-1 for each operational test release.

TABLE 4.3-1:
INDIVIDUAL DOSES AT THE LOCATION OF MAXIMUM DOSE FROM OPERATIONAL RELEASES FROM EACH TEST AND TOTAL PROGRAM NEAR SMTS[1] (U)

Test Article	Highest Organ	Maximum Committed Organ Dose (mrem)	Distance (km)	Committed Effective Dose Equivalent (mrem)	Distance (km)
PIPET, Mini GTA	Thyroid	4.9×10^{-2}	187	9.7×10^{-3}	46
GTA #1, #2, etc	Thyroid	4.2×10^{-1}	198	6.9×10^{-2}	46
QTA	Bone Surface	5.4×10^{0}	27	5.9×10^{0}	28
Total[2]	Thyroid	2.1×10^{1}	–	8.6×10^{0}	–
NESHAPS[3]	N/A	N/A		10.0	

[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) The total dose would be spread over the duration of the project (i.e., about 4 years) and includes all ground testing.

[3] (U) EPA 40 CFR 61, Subpart H limits radiological exposure to the public to 10 millirem/year from each DOE installation, such as NTS or INEL.

(U) The highest committed organ dose[3] (thyroid) and Committed Effective Dose Equivalent (CEDE) received by the hypothetical person residing at the location of maximum dose were calculated to be 0.049 millirem [at 187 km (116 mi)] and 0.0097 millirem [at 46 km (29 mi)], respectively from each PIPET or mini-GTA test. The highest committed organ dose (thyroid) and Committed Effective Dose Equivalent received at the location of maximum dose were calculated to be 0.42 and 0.069 millirem, respectively for each GTA test. The dose from QTA testing would be 5.4 mrem [at 28 km (17 mi)] committed organ dose (bone surface) and 5.9 mrem CEDE (at 28 km) to the individual located at the location of maximum dose. The total dose received by the hypothetical individual residing at the location of maximum dose from all ground testing was calculated to be 21 millirem committed organ dose (thyroid) and 8.6 millirem CEDE, spread over a period of approximately 4 years. The organs are used as an indicator of the exposure of individuals to radiation. The consequences of this exposure are measured as latent cancer fatalities and genetic defects to offspring.

(U) Virtually all the dose received would be received within the first year. For the purposes of this analysis, the CEDE and annual EDE are considered equivalent. The expected average annual dose to the maximally exposed individual during testing would be 2.2 mrem/year (CEDE). In comparison, the annual effective dose equivalent typically received by individuals at the NTS due to natural background would be 67 millirem. The additional annual effective dose equivalent received by the maximum individual from other NTS operations was about 1.5 x 10^{-4} millirem in 1989 (DOE, 1990a).

(U) Based on health effect risk estimator for fatal cancers of 7.9 x 10^{-4} per person-rem (EDE), the risk to the hypothetical individual residing at the location of maximum dose due to SMTS activities would be about 7 x 10^{-6} cancer fatalities. Based on the risk estimator of 2.6 x 10^{-4} genetic effects per person-rem (EDE), the risk to the offspring of the same individual would be about 2 x 10^{-6} genetic disorders. That is to say, the maximally exposed individual would face an increased risk (above the already existing risk of 2.2 x 10^{-1}) of dying of cancer of 7 x 10^{-6}. This same individual would face an increased risk (above the already existing risk of 2.5 x 10^{-2}) of producing offspring with genetic defects of 2 x 10^{-6}.

(U) If radiological exposures from this program occurred at the NESHAP limit of 10 mrem per year for the four years of the project, expected health effects to the maximally exposed individual would be 3 x 10^{-5} latent cancer fatalities and 1 x 10^{-5} genetic defects.

Population (U)

(U) The minimum and maximum downwind population doses due to normal releases from SMTS operations for the population 80 kilometers (50 mi) downwind of the SMTS are summarized in Table 4.3-2. Winds blowing toward the following approximate directions were eliminated from consideration to prevent excessive population doses: winds blowing approximately toward the

[3](U) The organ receiving the maximum dose differs, depending upon the radionuclide mixture to which the individual is exposed. This mixture depends upon the source term, release fraction, atmospheric transport, and radiological decay. All significant organ doses have been determined and the maximum is quoted in the text. The program total organ dose is determined by summing the doses for each organ across all tests and selecting the maximum.

[redacted]

TABLE 4.3-2: COLLECTIVE POPULATION DOSE FROM ROUTINE OPERATIONS AT NTS[1] (U)

Operations	Committed Effective Dose Equivalent (person-mrem)	
	Minimum[2]	Maximum[2]
PIPET, Mini-GTA	4.5×10^{-1}	5.9×10^{-1}
GTA, #1, #2, etc.[1]	1.0×10^{1}	1.2×10^{1}
QTA	2.6×10^{1}	4.3×10^{1}
Total[3]	2.5×10^{2}	3.0×10^{2}

[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) Restricting heavily populated sectors from consideration (winds approximately toward 90° clockwise through 292.5°).

[3] (U) The total population dose equivalent represents the dose equivalent to the population within 80 kilometers (50 mi) of the SMTS from all operational releases over the length of the test period (i.e., spread over about 4 years) assuming the wind were blowing in the same direction for every test. Actual wind direction variation would result in a population dose between the minimum and maximum dose.

[redacted]

east (90°) clockwise through winds blowing approximately toward the west-northwest (292.5°). This would be an operational limitation on the conduct of tests; if tests were conducted while winds were blowing in this direction excessive doses could occur to the population. The dose values presented in the following paragraphs are the maximum population doses that would be experienced for winds in the operational sectors.

(U) The collective CEDE due to a PIPET test or mini-GTA was calculated to be 0.45 to 0.59 person-mrem (depending on the direction of the wind) to the population 80 km downwind. The collective CEDE to the same population for GTA tests was calculated to be 10 to 12 person-mrem. For QTA operations, the collective CEDE was calculated to be 26 to 43 person-mrem from each test. The total collective CEDE for all ground testing, over the entire length of the testing period (i.e., about 4 years) was calculated to be 250 to 300 person-mrem. The annual collective whole-body dose due to natural background radiation for the same population would be about 784,000 person-mrem. The collective dose received by this population from other NTS operations was about 1.1 person-mrem during 1989 (DOE, 1990a).

(U) Based on the health effects risk estimators for genetic effects and cancer fatalities, the population 80 kilometers (50 mi) downwind of the SMTS project would experience about 2×10^{-4} additional latent cancer fatalities and 6×10^{-5} to 8×10^{-5} additional genetic disorders from the project's atmospheric emissions resulting from all routine ground testing procedures. That is to say, since 22 percent of the affected population of 5,400 (1,188 individuals) are ordinarily expected to die from cancer (Krieger, 1991), the performance of ground testing activities would add only 2×10^{-4} cancer fatalities to this for an expected cancer fatality total of 1,188.0002. This same population would ordinarily be expected to produce 2.2 percent of its offspring (or 119 individuals) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 6×10^{-5} to 8×10^{-5} additional genetic disorder cases to the offspring of the entire population from normal operations.

Other Biota (U)

(U) Radiation doses received by wildlife and crops from radioactive material released during normal SMTS operations are expected to be similar to those received by humans. External doses to humans would be slightly higher than those to other biota, while internal doses are expected to be within an order of magnitude. The difference in internal doses would be due to the different pathways and metabolisms involved (e.g., humans and animals can breathe and ingest radioactive material, while crops absorb radioactivity through roots and foliage). Since the radiological effects for humans are expected to be extremely small, the same would be expected for doses to wildlife and crops.

(U) There is a direct correlation between the biological complexity of an organism and its sensitivity to radiation (BEIR, 1972). Evidence indicates that no other living organisms have been identified that are likely to be significantly more radio-sensitive than man (BEIR, 1972). Because the doses received by humans, very complex organisms, would result in insignificant impacts, similar doses received by simpler organisms would be even less effective.

Routine Transportation (U)

(U) Routine transportation of radioactive materials (and hazardous wastes) is discussed in Section 2.4.1. Shipment of fissile radioactive materials is regulated by the requirements of 49 CFR 173, Subpart I. Other transportation requirements for shipment of radioactive material (also in 49 CFR 173, Subpart I) limit external radiation dose rates, radioactive material contamination levels, temperature, pressure and containment.

(U) The environmental consequences associated with routine (non-accident) transportation of uranium bearing fuels, both unirradiated and irradiated, TRU waste, and low-level waste from the program are analyzed.

(U) The radiological impacts have been calculated, using the RADTRAN 4 computer system (Neuhauser and Kanipe, 1991). Data used in the analysis includes the material properties characteristics of shipping containers and contents, transport vehicles, numbers of shipments and distances traveled, and population distribution for actual routes to and from the facilities involved. Appendix A provides a detailed discussion of the transportation modeling effort.

(U) The radiological impacts result from limited direct external radiation exposure to people sharing the roads with transport vehicles and those living near the roads or near rest stops. The incremental population dose increase to this group from incident free SMTS material shipments is conservatively calculated to be 120 person-rem. The corresponding risk of radiation-induced health effects for this same population would be 5.9×10^{2} latent cancer fatalities and 2.4×10^{2} genetic disorders.

4.3.4.2.2 Postulated Facility Accidents (U)

Introduction (U)

(U) The following sections address accidental releases that could hypothetically result from ground tests. Since the design and safety analysis are in the preliminary phase, expectation of events are based on engineering judgements. While today's best engineering judgements cannot assign a definitive probability of occurrence for this bounding case accident scenario, the likelihood of this scenario occurring exactly as postulated is extremely low. As the design evolves, a complete probabilistic risk analysis would be performed for this bounding case accident as well as for various less severe accidents. Moreover, the design criteria would include sufficient margins to assure that radiological doses would not exceed allowable limits.

(U) The postulated facility accident would take the form of a vaporization caused by the rapid heating of the test article [20,000 K (20,000° C) per second)]. The vaporized material would then be released as a plume to the atmosphere. This accident would not result in a nuclear explosion because the test articles contain neither sufficient refined material nor a triggering device.

(U) The approach taken was to develop a hypothetical bounding case accident scenario as a bounding case, to apply these results to the proposed site at NTS, and then to postulate accidents

[redacted]

of less severe consequence related to PIPET and the mini-GTA. Dose receptors (individuals) of concern are the test personnel (occupational workers) stationed in the SMTS control bunker during the test, other NTS personnel assumed to be evacuated prior to each test and not at risk from accidental releases, members of the public at the location of highest dose (maximum offsite individual), and members of the public residing offsite out to a distance of 80 kilometers (50 miles).

(U) The applicable dose limits for occupational exposures are given in DOE Order 5480.11, and are 5 rem annual effective dose equivalent and 50 rem annual dose equivalent to any organ of the body except the lens of the eye (15 rem annual dose equivalent). In the event of an emergency, DOE Order 5480.11 allows a one time whole body dose of 25 rem. Applicable public dose limits appear in DOE Order 5400.5, "Radiation Protection of the Public and the Environment" and 40 CFR Part 61, "National Emissions Standards for Hazardous Air Pollutants" Subpart H, for normal operations, and by 10 CFR 100 for accident conditions. However, for the ground test facility, ANSI/ANS 15.7 has been identified as the applicable siting regulation. The maximum allowable dose to an offsite individual from a reactor accident specified in ANSI/ANS 15.7 are 5 rem whole body and 15 rem to any organ from a 2 hour exposure. The maximum allowable doses at the urban boundary are 0.5 rem whole body and 1.5 rem to any organ from a 24 hour exposure.

(U) ANSI/ANS 15.7 defines radiological dose limits in terms of zones around the test facility. The innermost zone, the operations area, is that area in the immediate vicinity of the test facility set off by a physical barrier such as a fence over which the test facility administrator has control of access and activities. The operations area is surrounded by a site in which there may be people only generally aware of test facility activities and emergency responses. Outside the site is a rural zone, generally an area which may include members of the general public, but limited to populations which allow reasonable expectation that the people can be evacuated or protected within about two hours. The urban zone (i.e., the area outside the rural zone) includes populations too large to assume such evacuation or protection.

(U) The actual population accident exposure pattern would most likely lie only in one wind direction because of the short term nature of the accidental release. Limitations on the wind direction prior to testing would also limit the exposure direction.

Methodology (U)

(U) Consequence assessment was developed using the MACCS computer code as described in the normal operations impact assessment (Section 4.3.4.2.1). The accident modeling scenario assumes that the full operating plume power would be released over a 60 second time period. Accident core release fractions are conservatively defined as 1.0 (100% release). The effects of the ETS were not included in the scenario.

(U) Weather conditions assumed in the analysis were a wind speed of 5.5 meters per second (18 fps) and Pasquill Stability Class D. An inversion layer was assumed at 2,000 meters (6,600 ft).

[redacted]

([redacted]) ORIGEN2 (Croff, 1983) was used to develop the radionuclide inventory. A nuclear cross section most closely approximating this reactor core was used. The GTA and QTA reactor core history was assumed to be 2000 MW for 1000 seconds. The PIPET and Mini-GTA reactor history was assumed to be 550 MW for up to five 500 second runs. These parameters were selected to generate a reasonable bounding case estimate of the fission product inventory for the assemblies. These assumptions are discussed in Section A.4 of Appendix A.

(U) Plume rise was calculated based on the plume thermal energy content assuming a release height of 6 meters (20 ft) (1 meter above the top of the building). The results of a release at ground level (0 meters) were compared with releases at 8 meters (26 ft) and 16 meters (53 ft). The release height had no noticeable effect on the resulting doses.

Bounding Case Accident Scenario (U)

(U) The bounding case accident scenario would be the complete release of the GTA fission product inventory as an aerosol and gases for dispersion downwind. These results would be used to evaluate proposed sites and for comparison with accidents of lesser consequence.

(U) The mini-GTA would be the same size and have a similar core history as PIPET, and thus would result in a similar potential accident dose as PIPET. This dose would be well below that for the bounding case accident which involves GTA or QTA.

(U) The ETS is not considered in the accident scenarios. The ETS would be designed to be functional during accidents and would effectively reduce the effluent source term and resulting dose commitments[4].

Other Accidents - PIPET Failure (U)

(U) The PIPET tests would run at only a fraction of the power and time of the full scale (GTA) tests. Thus the maximum fission product inventory would be substantially less than the bounding case GTA accident. This would result in a proportionally lower dose. The end result would be a lower dose to the maximally exposed individual from this hypothetical accident.

Other Accidents - GTA/QTA Failure (U)

(U) These assemblies are the same in terms of reactor core size and anticipated run time, and are identical to the assumptions used for the bounding case accident. Thus the bounding case accident does bound accidents which could occur in any of these tests.

Other Accidents - Natural Phenomena (U)

(U) Several accidents due to natural phenomena, that could cause a release of radioactive materials are bounded by the bounding case accident. Such accidents are equally likely to occur

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[4](U) Although the bounding case accident is demonstrated not to cause significant health impacts, the ETS is still required during normal operations to overcome any uncertainty in potential test effluents as well as to achieve DOE's ALARA program dose levels.

during periods of reactor shutdown when fission product inventories are low, as during test activities, but even during full power operation, releases occurring during full test operation are properly bounded by the full core inventory release (bounding case accident).

Occupational Exposure (U)

(U) Design detail uncertainties preclude dose calculation to control bunker personnel. Dose to the test personnel housed in the control bunker would be mitigated by the control facility design. Earth covering and structural material would reduce external radiation exposure, and HVAC design would be adequate to prevent excessive exposure to airborne radioactivity. Evacuation procedures would be in place to assure personnel protection following any accident.

Offsite Dose Consequences Due to Bounding Case Accidents (U)

(U) Distances to site boundaries and terrain characteristics would affect the dose received by the offsite population. Wind direction, wind speed, and meteorological conditions also significantly affect the dose to the offsite population. Operational constraints would be applied, such that testing would only be performed when meteorological conditions are acceptable. Committed Effective Dose Equivalents to the maximally exposed individual and the dose to the population 80 kilometers (50 miles) downwind from the postulated bounding case accident are summarized in Table 4.3-3.

(U) The location of maximum dose downwind from the accident, indicates a Committed Effective Dose Equivalent 20 mrem at 34 km (21 mi) from an accident during PIPET or mini-GTA operation.

(U) The GTA or QTA accident scenario resulted in a Committed Effective Dose Equivalent at the location of maximum dose [34 km (21 mi)] of 130 mrem. These doses were calculated assuming that an individual resided at the centerline of the plume as it passed overhead.

(U) The increased risk from the (bounding case) GTA accident is estimated to be 1×10^{-4} latent cancer fatalities and 3×10^{-5} genetic defects. That is to say, the maximally exposed individual would face an increased risk of dying of cancer of 1×10^{-4}. This same individual would face an increased risk of producing offspring with genetic defects of 3×10^{-5}.

(U) If an accident occurs resulting in radiological exposures at the ANSI/ANS 15.7 limit of 500 mrem, expected health effects to the maximally exposed individual would be 4×10^{-4} latent cancer fatalities and 1×10^{-4} genetic defects.

[redacted]

TABLE 4.3-3:
COMMITTED EFFECTIVE DOSE EQUIVALENT AT THE LOCATION OF MAXIMUM OFFSITE DOSE AND COLLECTIVE POPULATION DOSE FROM ACCIDENTS AT THE NTS[1] (U)

Maximum Individual:

Test System	Highest Organ	Maximum Committed Organ Dose (mrem)	Distance (km)	Committed Effective Dose Equivalent (mrem)	Distance (km)
PIPET, Mini-GTA	Bone Surface	2.2×10^1	34	2.0×10^1	34
GTA and QTA	Bone Surface	1.5×10^2	34	1.3×10^2	34

Population:

Test System	Committed Effective Dose Equivalent (person-mrem)	
	Minimum[2]	Maximum[2]
PIPET, Mini-GTA	5.5×10^1	1.2×10^2
GTA and QTA	6.7×10^2	1.2×10^3

[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) Downwind population dose, restricting heavily populated sectors from consideration (winds approximately toward 90° clockwise through 292.5°).

[redacted]

[redacted]

Population (U)

(U) The collective whole body dose to the downwind population 80 kilometers (50 mi) of the accident scenarios was calculated to be 55 to 120 person-mrem from an accident during PIPET or mini-GTA tests. The population CEDE is projected to be 670 to 1200 person-mrem for the GTA or QTA accident. As discussed previously, the operation of the SMTS would be dependent on the wind direction, wind speed, and other meteorological conditions. If the test systems are only operated when the wind is blowing towards the north, the collective whole body dose would be substantially lower since few people reside north of the NTS. The additional cancer fatalities and additional genetic disorders expected to be caused by the bounding case accident scenario would be 5×10^{-4} to 9×10^{-4} and 2×10^{-4} to 3×10^{-4} respectively. That is to say, since 22 percent of the affected population of 5,400 (1,188 individuals) are ordinarily expected to die from cancer (Krieger, 1991), the performance of ground testing activities would add only 5×10^{-4} to 9×10^{-4} cancer fatalities to this for an expected cancer fatality total of 1,188.0007. This same population would ordinarily be expected to produce 2.2 percent of its offspring (or 119 individuals) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 2×10^{-4} to 3×10^{-4} additional genetic disorder cases to the offspring of the entire population from normal operations.

4.3.4.2.3 Transportation Accidents (U)

(U) The impacts of potential accidents involving the transport of unirradiated and irradiated fuel including transport of radioactive and mixed wasted were analyzed using the RADTRAN 4 code (Neuhauser and Kanipe, 1991 in preparation). The analysis required a definition of the properties of the material to be transported, a description of accidents that might occur, and representative transportation routes. It was assumed that materials shipments include the following: shipment of fuel material to Lynchburg, VA, from Oak Ridge, TN; select unirradiated fuel specimens from Lynchburg, VA, to Albuquerque, NM; and shipments of unirradiated fuel elements and assemblies, up to and including full GTA from Lynchburg, VA, to NTS, including onsite transportation. The irradiated fuel elements are assumed to be shipped back to Lynchburg, VA, for analysis. Details of the transportation analysis are presented in Section A.3 of Appendix A.

(U) The transportation analysis uses both route-specific and national average transportation data. The route-specific data include total distance, adjacent population, and fraction of the route on various types of roads (e.g., rural, urban, or suburban). The road-type fractions are then combined with national average truck accident data for each road type, and data specific for DOE Safe Secure Transport (SST) shipment. The national average data used in the analysis yield accurate risk estimates for the cross-country routes to which they were applied. Data included in Appendix A show that the national average combination-truck accident rate on interstate highways is about 3.1×10^{-7} accident per kilometer. Limited variability in accident rates supports the use of national average data. For onsite shipments, the analysis does account for relevant site-specific factors such as low population density.

(U) Weather-related road closures in the region are not expected to affect the risk estimates. Effects due to weather would be kept to a minimum by considering actual and forecast road

[redacted]

conditions and by not dispatching trucks either in bad weather or under poor forecast conditions. Restricting truck transport to good weather conditions would reduce the overall truck accident rate by only about 10 percent (NRC, 1977). Since accidents associated with travel in poor weather conditions are included in the DOT accident-rate data that were used in the risk analysis, the risk estimate is slightly conservative with respect to this parameter. The stop time is based on actual operational requirements for SST shipments. A decreased stop time does result in a decrease in incident-free risk, but has no effect on accident risk calculations.

(U) The consequences of a severe accident involving the transport of enriched uranium are presented in the NRC Final Environmental Impact Statement on Radioactive Material Transport (NRC, 1977) in terms of both the number of potential latent cancer fatalities and the economic consequences (e.g., cleanup and agricultural products). The consequences of the severe uranium accident presented in NRC (1977) are probably higher than those associated with enriched unirradiated uranium because of improved containment afforded by the SST. In evaluating both the consequences and risks of radioactive material transport, including severe accidents, the NRC concluded that "the risks attendant to accidents involving radioactive material shipments are sufficiently small to allow continued shipments by all modes."

(U) The estimated radiological risks from transportation accidents associated with program shipments would be 8.5×10^{-4} person-rem. This exposure would result in 4.2×10^{-7} latent cancer fatalities and 1.7×10^{-7} genetic effects. Risk of nonradiological fatalities is 0.21 for this facility.

4.3.4.3. Projected Doses (U)

(U) A summary of the projected doses at program model conditions is compared to the standards below:

<u>PIPET/Mini-GTA</u> (U)

(U) Current radiological impact assessments indicate that normal operation of PIPET/Mini-GTA would be below the 10 mrem/year NESHAP standard. The controlled element failure test is predicted to be below the NESHAP limit. PIPET/Mini-GTA accident impacts would be below the ANSI/ANS 15.7 limit.

<u>GTA</u> (U)

(U) GTA normal operations do not exceed the NESHAP limit. For the GTA accident, the ANSI/ANS 15.7 limit would not be exceeded.

<u>QTA</u> (U)

(U) Operation of the QTA at expected power levels without an ETS would result in a dose that does not exceed the standards for both the operation and accident case.

Synopsis (U)

(U) Because the predicted radiological effects of ground testing and transporting of radiological materials as well as the radiological effects of the bounding case accident are sufficiently low that increased health effects are not expected, the impact of radiological emissions on the environment would be negligible. Therefore, the environmental consequences would be insignificant.

4.3.5 Summary of Environmental Consequences at SMTS (U)

(U) Noise is the only area that has a potential for high impact at SMTS. However, since members of the general public would not be exposed to these noise levels, and since the few workers (five) in the area during testing operations would be subject to the mitigation measures discussed, the environmental consequences of noise would be insignificant. Although there is a potential for moderate impacts to site workers as a result of the storage and handling of process fluids, the mitigation measures discussed would reduce the probability of an accident to very low levels and result in insignificant environmental consequences. Because the site is far removed from the general public, there are no effects to public health and safety.

(U) There would be a potential for low impacts for waste at SMTS. Waste would be processed within the existing NTS process streams and within compliance of all existing environmental regulations. Environmental consequences would, therefore, be insignificant.

(U) Cultural and biological impacts are rated low pending a cultural and biological resources survey of the proposed waterline and power line to the water supply well at SMTS. Relocation of the waterline and power line to avoid areas of importance or recovery of resources would mitigate potential impacts. Cultural and biological surveys would be conducted and the appropriate agencies would be consulted prior to any construction activities at SMTS. Environmental consequences, therefore, would be insignificant.

([redacted]) Radiological impacts would be negligible at SMTS. Analysis of the radiological dose from the facility indicates that the estimated risk of additional latent cancer deaths and genetic defects are sufficiently small that no health effects (anticipated cancer deaths or genetic defects as a result of routine operations or an accident) would be expected from radiation exposure at the program model conditions or at applicable standards. Environmental consequences, therefore, would be insignificant.

4.4 QUEST SITE - IDAHO NATIONAL ENGINEERING LABORATORY (INEL) (U)

(U) This section discusses the expected environmental consequences of constructing and operating the proposed ground test facility at the QUEST Site at INEL. The discussion includes potential radiological and non-radiological impacts that result from routine operations and as a result of abnormal events or accidents.

(U) The environmental consequences of locating the ground test facility at the QUEST Site are based on the same atmospheric emissions, liquid effluents, solid wastes, and radiological source terms for normal and accidental releases previously discussed in Section 4.3.

(U) Construction of new facilities would be phased similarly to the proposed SMTS with an initial sub-scale facility expanded to a full-scale facility after successful completion of PIPET and mini-GTA testing.

(U) The normal operational impacts associated with locating the ground test facility at the QUEST site would be similar to those described for locating the project at the SMTS at NTS. The following sections describe the impacts associated with locating the ground test facility at the QUEST site.

4.4.1 Socioeconomics (U)

4.4.1.1 Population and Economy (U)

(U) Construction of the sub-scale and full-scale facilities at QUEST would require a similar time period (approximately 18 months each) and work force (35-100 employees) as constructing the facilities at the NTS.

(U) The construction workforce would not cause an additional demand for services and facilities because: (1) the required construction workforce is small and (2) most of the workforce would be drawn from construction craft workers at INEL. The impact of the construction workforce on the population and economy would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Operation of the ground test facility at the QUEST site would require the same number of operating personnel (60) as would operation at the SMTS. Based on the total number of approximately 11,000 people currently employed at INEL, the 60 extra personnel required for operation of the ground test facility represents only 0.5 percent of the workforce. This small percentage of extra workers would cause no increased demand for services and facilities ensuring that the operation of QUEST would impose only a negligible impact on the population and economy. Therefore, the environmental consequences would be insignificant.

4.4.1.2 Land Use and Infrastructure (U)

(U) The land area that would be affected at the QUEST Site has no existing facilities and has not been used previously for INEL operational activities. Less than 40 hectares (100 acres)

would be used by the ground test facility. This is only 0.03 percent of the total land area of INEL [230,000 hectares (570,000 acres)]. The construction of the QUEST facility would not necessitate the construction of offsite support facilities.

(U) Since the construction of the QUEST facility would be compatible with existing land use, would cause only a minor reduction in the supply of vacant land, and would not require extensive offsite equipment or facilities, the impact of construction on land use and infrastructure would be negligible. Therefore, the environmental consequences would be insignificant.

(U) The operation of the ground test facility might preclude the use of land for other activities. Areas adjacent to the QUEST facility are used for grazing. This would no longer be possible within 3 km (2 mi) of QUEST during testing periods. A major accident could preclude the use of grazing area for several days. Operations would deplete the supply of useable grazing land, the impact of operations on land use would be low but temporary. Because the affected land area is small, would be impacted for a short duration, and is not in close proximity to special use areas, the impact would be low. Therefore, the environmental consequences would be insignificant.

(U) The operation of the ground test facility would require no additions of facilities or equipment from the local infrastructure. However, during testing operations it is likely that public roads within 15 km (9 mi) of the ground test facility and within the favorable winds testing zone (212.5° clockwise to 22.5°) would be temporarily closed. This would include only State Road 33 [with an average daily traffic of 1,170 (DOE, 1991a)], which may be detoured using State Roads 28 and 22. Closing State Road 33 during testing would cause a disruption of traffic flow through the facility. In the context of the total traffic volume, however, the disruption would be temporary, infrequent, and of short duration. Since operations at QUEST would require temporary changes in operations practices and cause degradation of existing service, the impact of operations on infrastructure would be low. Because of the sort duration and infrequent occurrence of the testing operation as well as the availability of alternative routes, the impact would be low and the environmental consequences would be insignificant. (Although the impact would be insignificant, the disruption could be minimized by scheduling testing at projected low traffic use periods).

4.4.1.3 Noise[1] (U)

(U) Noise impacts for the construction of the QUEST site would be the same as those for the SMTS (a maximum of 90 dBA produced by large internal combustion engine powered equipment). As described for the SMTS, mitigation includes following OSHA workplace noise regulation with hearing protection supplied as appropriate.

(U) Non-project related personnel at INEL would not be affected by the construction noise. The distance from QUEST to the main road is 12 km (8 mi).

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[1] (U) Noise effects on fauna are addressed in Section 4.3.3.

(U) Sensitive receptors in areas outside INEL are not likely to experience any noticeable increase in noise levels because of the long distance from the QUEST site to the nearest INEL boundaries [16 km (10 mi)].

(U) Operational noise issues are the same at QUEST as at the NTS; significant noise levels (110 dBA for short infrequent intervals) associated with ground testing activities would raise ambient levels by more than 35 dBA and could exceed OSHA short-term exposure limits. Mitigation is the same for the QUEST site as for SMTS which includes sound barriers, hearing protection, and the physical isolation of non-essential personnel from the facility during testing.

(U) During operations, all non-essential personnel would be excluded from the test site and stationed at least 5 km (3 mi) away and would not be adversely impacted. Non-project related sensitive receptors in nearby communities would be out of range of the noise [at least 55 km (33 mi) away] and would suffer no impacts from noise levels.

(U) Construction noise would be raised above ambient levels (22-38 dBA) by more than the high significance criteria level of 35 dBA and could exceed the OSHA 8 hour long-term exposure limit (see Appendix D). In addition, noise from normal operations would be raised above ambient levels by more than the high significance criteria level of 35 dBA and could exceed the OSHA short-term exposure limit. Therefore, the impact of construction and operations activities on noise would be high and the environmental consequences could be potentially significant. However, because there are no sensitive receptors in proximity to the site and because hearing protection is required for operations personnel, the environmental consequences would be insignificant.

4.4.1.4 Historic and Archaeological Resources (U)

(U) Although detailed cultural surveys have not been performed for the QUEST area, ground reconnaissance of the site identified isolated artifacts (mainly stone chips and flakes scattered over the surface). The small individual sites themselves are typically not significant, however, their content and location should be accurately recorded as an accurate description of all sites in the region. Such a record would provide insight to prehistoric and historic cultural activity and would be a valuable resource. However, since there would be a minimum loss of artifacts processing scientific and cultural importance, the impact of activities to cultural resources at the QUEST site is considered low.

(U) Prior to any ground disturbance, detailed cultural resource surveys would be undertaken and, following consultation with the Idaho State Historic Preservation Office (SHPO), appropriate mitigation measures would be implemented prior to construction if these are required for SHPO concurrence. Mitigation measures would include 1) identification and recovery of artifacts; 2) relocation of facilities; and 3) flagging of sites to be left undisturbed. As a result of SHPO consultation and implementation of any required mitigation measures, environmental consequences would be insignificant.

4.4.1.5 Safety (U)

(U) As at SMTS, the design of the test facility at the QUEST site has no unusual features which would increase work hazards during construction. No additional occupational impacts beyond those currently experienced in construction activities at INEL are expected. Therefore, the impacts of construction on safety would be low but mitigable. Mitigation includes ensuring that all construction activities would be carried out in compliance with applicable OSHA and DOE regulations.

(U) Except for the potential for seismic and volcanic activity, the safety issues at QUEST are identical to those for SMTS [See Section 4.3.1.5 for a description of these safety issues and their impacts.]

Seismic and Volcanic Safety (U)

(U) The INEL is in an active seismic area. Two earthquakes over magnitude 7.0 on the Richter scale have occurred within 320 km (200 mi) of INEL in the past 35 years. Significant seismic activity might cause a leak in the hydrogen tanks or piping leading to a deflagration or detonation of hydrogen. Mitigation includes the design of buildings to a Seismic Zone 4 rating. Because the possibility of seismic activity would increase the danger to personnel above baseline conditions, the impact of seismic activity on safety at QUEST would be low. Therefore, the environmental consequences would be insignificant.

(U) INEL is in a formerly active volcanic activity area. No volcanos have occurred in this area in at least 2,100 years. Since there is little probability that a volcano would occur during the life of the proposed action, volcanic activity would have a negligible impact on safety at QUEST. Therefore, the environmental consequences would be insignificant.

Synopsis

(U) Due to the large quantities of hydrogen that would be stored and used at the ground test facility, activities taking place at QUEST would have a moderate impact on safety. There is a potential for moderate impacts to site workers as a result of the storage and handling of process fluids. Therefore, the environmental consequences would be potentially significant. However, the mitigation measures discussed above and in Section 4.3.1.5 would reduce the probability of an accident to very low levels and result in insignificant environmental consequences. Because the site is far removed from the general public, there would be no effects to public health and safety.

4.4.1.6 Waste (U)

(U) Wastes generated by the operation of the facilities would be the same as those produced by proposed operations at SMTS. These include radioactive and hazardous wastes. These are discussed below:

Radioactive Waste (U)

(U) At QUEST, the types of radioactive waste that would most likely be generated as a result of operations include low-level waste, low-level mixed waste, and potentially some transuranic waste. Each are described below:

([redacted]) High-Level Radioactive Solid Waste: It is currently anticipated that with the relatively short operating time, the fuel material would not contain any transuranic material in excess of 100 nCi/g and the resultant material would be certified as fissionable test specimens which are handled as LLW. Any high level radioactive waste generated at QUEST in association with the [redacted] program ground testing would be in the form of spent reactor fuel. Such HLW would be treated in accordance with defense HLW and temporarily stored until a permanent storage facility is made available. The impact of HLW on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

([redacted]) Transuranic Waste. Transuranic wastes from ground testing activities are not expected to exceed 30 m^3 (1,000 ft^3). Since 1988, 64,000 m^3 (2,200,000 ft^3) have been stored at the Transuranic Storage Area awaiting shipment to WIPP for permanent disposal[2]. INEL presently has a remaining storage capacity of 595,000 m^3 (21,000,000 ft^3) for transuranic waste storage with an anticipated annual input of 2,900 m^3 (100,000 ft^3) [including 100 m^3/yr (3,500 ft^3) if NPR is built]. At the end of the 10 year life of the [redacted] Program, the remaining storage capacity at INEL would be 566,000 m^3 (20,000,000 ft^3). The amount of TRU waste anticipated to be produced by the program would represent less than 0.01 percent of the remaining capacity.

(U) Any TRU waste generated during test facility operations would be certified and shipped to WIPP for disposal. The TRU waste would be packaged and certified according to WIPP waste acceptance criteria. Since the TRU wastes generated would cause no changes in operational arrangements, the impact of TRU waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Low-Level Radioactive Solid Waste: Operation of the test facilities at INEL would generate the same kinds and quantities of waste as previously discussed for the NTS (Section 4.3.1.6). Approximately 46,000 m^3 (1,600,000 ft^3) of low-level radioactive solid waste would be generated by testing at QUEST. Prior to disposal, the waste would be packed in drums or LLW crates and nondestructively assayed. Solid waste is disposed of in the Subsurface Disposal Area (SDA) located in the Radioactive Waste Management Complex. As of 1988, the estimated volume of LLW buried at the SDA was 100,000 cubic meters (3,530,000 cubic feet) (DOE, 1988b).

(U) INEL presently has a remaining capacity of 100,000 m^3 (3,500,000 ft^3) for low-level radioactive solid waste with an anticipated annual input of 5,100 m^3 (180,000 ft^3) [including 2,200 m^3/yr (78,000 ft^3) if NPR is built]. At the end of the 10 year life of the program, the remaining capacity at INEL would be 78,000 m^3 (2,700,000 ft^3). The amount of solid LLW

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[2] (U) TRU wastes have been packaged and stored for over 20 years at existing DOE facilities while planning and preparation for permanent storage has been underway.

anticipated to be produced by the program would represent 60 percent of the remaining capacity. However, INEL is continually updating its solid LLW storage and disposal capacity requirements. Expansion of waste storage and disposal facilities is an ongoing process to meet the waste management mission of disposing of all waste. An inplace volume reduction program would reduce the input of solid LLW even more. Although, the solid LLW generated would cause no changes in operational arrangement, it does represent over half of the projected solid LLW inputs through the life of the project. Therefore, the impact of solid LLW on waste management would be low Therefore, the environmental consequences would be insignificant.

(U) <u>Mixed Waste:</u> Some mixed waste may be generated during program activities. This would include low-level radioactive materials contaminated by solvents or solvent residues. It is anticipated that no more than 0.2 m^3 (7 ft^3) or that material that could be contained in a single 55 gallon drum (210 liters) would be produced by program activities.

(U) INEL presently has a remaining capacity of 80 m^3 (2,800 ft^3) for mixed radioactive waste (Nelson, 1991a) with an anticipated annual input of 172 m^3 (6,900 ft^3) [including 160 m^3/yr (5,600 ft^3) if NPR is built]. The maximum anticipated input of mixed wastes [0.2 m^3 (7 ft^3)] is only 0.3 percent of the remaining capacity for mixed waste at INEL.

(U) Because the quantity of mixed wastes generated would be small, the impact of mixed waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

<u>Hazardous Waste</u> (U)

(U) Hazardous wastes that would be produced as a result of facility operations include limited quantities [approximately 15 m^3 (500 ft^3)] of solvents and materials such as gloves, paper, and cloth that contain absorbed solvents. A minimization program would be implemented to prevent the generation of any of these types of wastes. Hazardous wastes generated as a result of operations would be stored temporarily at the test facility and then transported to an EPA-approved treatment, storage, or disposal facility prior to the 90 day storage limit. All EPA and DOT regulations (i.e. 40 CFR 262-263 and 49 CFR 100-199) for the handling, sampling, manifesting, packaging, and shipment preparation of hazardous wastes would be followed.

(U) The hazardous waste generated would not pose adverse impact to operating employees, offsite population, or the environment. The hazardous waste could be handled under existing operational arrangements. Thus hazardous waste generated by facility operations would cause a negligible impact on waste management. Therefore, the environmental consequences would be insignificant.

<u>Non-Hazardous Waste</u> (U)

(U) Construction activities would generate the same quantities of uncompacted nonradioactive nonhazardous wastes as at the SMTS (discussed in Section 4.3.1.6).

(U) Sanitary Liquid Waste: It is anticipated that 18,000 m^3 (640,000 ft^3) of sanitary waste would be produced by construction and operation activities at QUEST. The quantities of sanitary effluents associated with the work crew are small when compared to those for all the other construction activities at INEL. Some additional collection and disposal facilities would be required such as the installation of temporary sanitary facilities. However, this is standard practice for construction activities at INEL. Operations at QUEST would require the installation of a septic tank and leach field. This is also standard practice for INEL facilities outside the reach of existing sewage facilities. Because the generation of sanitary liquid waste would not require changes in existing operational arrangements, the impact of sanitary waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Solid Waste: It is anticipated that 4,000 m^3 (140,000 ft^3) of non-hazardous, non-radioactive solid waste would be produced at INEL by the [redacted] program. This waste would be disposed of in the Central Facilities Area (CFA) Landfill. The amount of waste generated would not significantly impact the CFA Sanitary Landfill. Nonradioactive and nonhazardous wastes would be managed in compliance with Subtitle D requirements of RCRA. Because the generation of solid waste would not require changes in existing operational arrangements, the impact of solid waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

(U) In general, activities taking place at QUEST would have a low impact on waste management. Since the wastes generated by the [redacted] program would be managed in accordance with existing waste management procedures which include protection of the environment, the environmental consequences would be insignificant.

4.4.2 Physical Environment (U)

4.4.2.1 Topography (U)

(U) The construction of the 40 hectare (100 acre) ground test facility would require the cutting and filling of about 25,000-30,000 m^3 (33,000-39,000 ft^3). As at SMTS, there could be alterations of the natural surface drainage as a result of grading. Because the QUEST facility would be built in compatibility with existing contours and because the station's size would be minimized where possible and because little change would be made to the character of the area, the impact of the construction on topography would be negligible. There would be no impacts on topography from operations. Therefore, the environmental consequences would be insignificant.

4.4.2.2 Geology and Soils (U)

(U) As at NTS, the only geological effects of the construction of the QUEST facility are to the soils. Construction would cause leveling and/or resurfacing of the soils in the immediate area. Dust and soil would be transported by winds during construction activities, but the effect would

be local and temporary. Removal of vegetation from the construction area should not significantly increase soil erosion from rainfall since the vegetation is sparse and the ground surface is predominantly basalt. Protection against soil erosion would include the orientation of the facility parallel to the natural surface features to minimize drainage and erosion impact as well as the application of spray mist water to minimize wind-caused soil erosion.

(U) There are no known paleontological or mineral resources, agricultural soils or construction materials at the QUEST site. Because the proposed construction and operation of the QUEST facility would not cause the loss or irretrievable commitment of any geologic or soils resources, the project would have a negligible impact on geology and soils. Therefore, the environmental consequences would be insignificant.

4.4.2.3 Seismic and Volcanic Activity (U)

(U) Because construction and operations would not cause seismic and volcanic activity that would be noticeable to instrumentation or humans, the project would cause negligible impacts to seismic or volcanic activity. Therefore, the environmental consequences would be insignificant.

4.4.2.4 Water Resources (U)

(U) The water table in the location of the ground test facility, the Snake Plain aquifer, is over 140 m (approx 450 ft) below the earth's surface. There are no surface water resources in the vicinity of QUEST. As at NTS, water resources may be affected by water use and water quality. Each are described below:

<u>Water Use</u> (U)

(U) The volume of water to be used during construction and operation of the ground test facility approximates that used to build the SMTS. During construction, an estimated 60 million liters or 0.06 million m^3 (16 million gal) of water would be withdrawn from the Snake River Plain aquifer for potable water and construction use, while during operations, an estimated 11 million liters or 0.11 million m^3 (3 million gal) would be withdrawn per year. The construction withdrawal volume would represent about 1 part in 100,000 of the annual discharge of 6.2 x 10^9 cubic meters [6.2 x 10^{12} liters (1.6 x 10^{12} gal)] of the aquifer to the Snake River and 1 part in 30,000 of the 2.0 x 10^9 m^3 [2.0 x 10^{12} liters (5.0 x 10^{11} gal)] withdrawn by all users of the eastern Snake River Plain. The average annual project withdrawal for operations would represent about 1 part in 500,000 of the annual discharge of the aquifer to the Snake River and 1 part in 200,000 of the volume withdrawn by all users of the eastern Snake River Plain.

(U) All of the water used at INEL is withdrawn from the Snake River Plain aquifer. Of the 30 production wells on-site, 27 are routinely in use. The combined pumpage from these wells was approximately 7.9 million m^3 [7.9 billion liters (2.1 billion gal)] per year for the period 1982 through 1985. This is only 0.4 percent of the 2.0 billion m^3 [2 trillion liters (0.5 trillion gallons)] of the annual groundwater withdrawn by all users from the aquifer in the eastern Snake

River Plain. Most of the annual volume of water withdrawn from the aquifer in the eastern Snake River Plain [1.8 billion m^3 or 1.8 trillion liters (0.5 trillion gal)] is used for agriculture.

(U) The Idaho Operations Office has negotiated with the Idaho Department of Water Resources regarding a claimed water right for no more than 42 million m^3 [43 billion liters (11 billion gal)] withdrawal capacity per year under the Federal Reserve Doctrine. The State of Idaho has signed a Settlement Agreement and there have been public hearings. Based on these hearings, an Interlocutory Order will be generated. The INEL will abide by this Order as it affects water use until the adjudication process is complete (DOE, 1991a).

(U) The construction and operation requirements of the ground test facility at INEL would require 0.14 and 0.03 percent respectively of the remaining capacity for ground water use and 0.75 and 0.13 percent respectively of current usage at the INEL. Although the potential for construction of the NPR at INEL would strain the current allocation for water withdrawal at INEL, the effect of this ground test facility can still be considered negligible (Nelson, 1991b).

(U) Because water use would cause no measurable change in the water resource system, the impacts of water use on water resources would be negligible. Therefore, the environmental consequences would be insignificant.

Water Quality (U)

(U) As at SMTS, stored water could potentially leak and seep into the water table carrying surface pollutants. Domestic waste would be introduced into the environment only after processing through a septic tank and leach field. Spills of hazardous substances could introduce pollutants to the ground water table.

(U) Because there are no surface waters that could be affected, the depth of the water table reduces the potential for seepage of wastes into the ground water, the waste water produced by operations at the site would result in no easily measurable change in the water resources system. Therefore, the impacts of waste water on ground water resources would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

(U) The use of water and discharge of waste water would have a negligible impact on water resources. Because impacts would be negligible, and testing operations are of short duration (approximately four to ten years), environmental consequences would be insignificant.

4.4.2.5 Meteorology and Air Quality (U)

(U) There would be no impacts on meteorology as a result of construction and operation of the ground test facility.

(U) Air quality issues and impacts associated with construction and operation of the QUEST ground test facility would be identical to those affecting the SMTS. In general, the activities at

QUEST would have a negligible impact on meteorology and air quality. [See Section 4.3.1.2.5]. Since emissions are well below the threshold values and the emissions standards that protect human health and welfare, the environmental consequences would be insignificant.

4.4.3 Biological Environment (U)

(U) The same activities as those described for the NTS would impact the biological environment at QUEST.

4.4.3.1 Terrestrial Biota (U)

(U) The construction of the ground test facility would result in the loss of approximately the same land area as that impacted by the construction of a ground test facility at SMTS [40 hectares (100 acres)]. The land area affected by the proposed construction is predominately of the sagebrush vegetation community. Impacts on biological resources would result from the facility construction including loss of habitats, destruction of vegetation, loss of wildlife, and disruption of migration and breeding patterns.

(U) A pre-activity biological resources survey of the site would be performed and, if threatened or endangered species are identified, consultation with the U.S. Fish and Wildlife Service (FWS) would take place prior to any construction activity to ensure that construction activities would have a minimal impact on biological resources including threatened and endangered species such as the bald eagle and peregrine falcon that are known to inhabit INEL. Because affected land areas would be small, all effluents and emissions would comply with regulatory standards, and the land in the vicinity of QUEST does not support a great diversity, construction activities would have a low impact on terrestrial biota. Therefore, the environmental consequences would be insignificant.

(U) The same activities that impact terrestrial biological resources during operations at NTS are also an issue at QUEST. The impacts of noise, flaring of hydrogen, and hot hydrogen venting are discussed in Section 4.3.3.1. The pronghorn antelope, which frequent INEL, would flee the test area for short durations upon the commencement of testing. Mitigations that would help minimize any impacts to habitat and wildlife include rescheduling of activities to avoid seasonal sensitivity of a species, limiting the number of personnel in the area, controlling access, and minimizing disturbance to the site. Because QUEST is surrounded by habitats with low diversity and quality but has some seasonal wildlife activity, the impacts of operation on terrestrial biota would be low. Because testing would be scheduled to minimize impacts to species, unnecessary personnel would be excluded from the area, and any pronghorn antelope would flee the area for the short duration of testing, environmental consequences would be insignificant.

4.4.3.2 Aquatic Biota (U)

(U) Because there are no surface water resources in the vicinity of QUEST, the construction and operation of the QUEST facility would have a negligible impact on aquatic biota. Therefore, the environmental consequences would be insignificant.

4.4.3.3 Threatened and Endangered Species (U)

(U) There are two endangered species that frequent INEL: the peregrine falcon and the bald eagle. Both of these birds rarely frequent the QUEST site and avoid human activities. Therefore, the proposed action would have a negligible impact on threatened and endangered species. Therefore, the environmental consequences would be insignificant.

4.4.4 Radiological Impacts (U)

4.4.4.1 Radiological Impacts During Construction (U)

(U) Prior to construction, radiological monitoring as required by DOE Order 5400.1 would be performed at the proposed site to ensure no unacceptable soil contamination exists in the areas to be disturbed. If excess radiological contamination is found, the area would be remediated to acceptable levels before construction begins. Dust control techniques would be used as appropriate, and any contamination present at low levels would be dispersed or settle out before it reaches the INEL site boundary. Offsite exposures from construction activities would, therefore, be negligible.

4.4.4.2 Radiological Impacts During Operations (U)

4.4.4.2.1 Normal Operations (U)

([redacted]) Radiological releases from [redacted] program sources are not anticipated to differ from those previously discussed at the NTS; however, the location of the project relative to the site boundaries and the surrounding population, and the different distances to facilities that would be involved in routine shipments of program materials would result in small differences in potential environmental consequences.

(U) This section considers the QUEST site. The QUEST site is approximately 16 kilometers (10 miles) for the nearest INEL site boundary. This distance is about 7 kilometers (4.3 miles) less than the distance to the site boundary at the NTS. The population within an 80 kilometer (50 mile) radius of both sites at INEL of 127,494 people was used for this analysis.

(U) The following sections briefly discuss the results of the calculations for locating the test facilities at QUEST. The methodology used to perform these calculations is discussed in Section 4.3.4.2 and Appendix A.

<u>Maximum Offsite Individual Dose</u> (U)

(U) The individual doses associated with normal operations are summarized in Table 4.4-1.

(U) The Committed Effective Dose Equivalent at the location of maximum offsite dose was calculated to be 9.7 x 10^{3} millirem [at 46 km (29 mi)] for routine releases from each PIPET or Mini-GTA test. The effective dose equivalent at the same location from each GTA test was calculated to be 0.069 millirem, [at 46 km (29 mi)] and the dose from the QTA test was

[redacted]

TABLE 4.4-1:
INDIVIDUAL DOSES AT THE LOCATION OF MAXIMUM OFFSITE DOSE FROM OPERATIONAL RELEASES FROM EACH TEST AND TOTAL PROGRAM NEAR QUEST[1] (U)

Operation	Organ	Maximum Committed Organ Dose (mrem)	Distance (km)	Committed Effective Dose Equivalent (mrem)	Distance (km)
PIPET, Mini-GTA	Thyroid	4.9×10^{-2}	187	9.7×10^{-3}	46
GTA #1, #2, etc.	Thyroid	4.2×10^{-1}	198	6.9×10^{-2}	46
QTA	Bone Surface	5.4×10^{0}	27	5.9×10^{0}	28
Total[2]	Thyroid	2.1×10^{1}	--	8.6×10^{0}	--
NESHAP[3]	N/A	N/A		10.0	

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[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) The total dose is spread over the duration of the project (i.e., about 4 years) and includes all ground testing.

[3] (U) EPA 40 CFR 61, Subpart H limits radiological exposure to the public to 10 millirem/year for each DOE installation like NTS or INEL.

[redacted]

calculated to be 5.9 millirem [at 28 km (17 mi)]. The maximally exposed organ for the PIPET or mini-GTA tests was the thyroid with a calculated dose of 0.049 millirem [at 187 km 116 mi)]. The GTA test resulted in a maximum organ dose (thyroid) of 0.42 millirem [at 198 km (123 mi)]. The maximum organ dose (bone surface) from each QTA test were calculated to be 5.4 millirem [at 27 km (17 mi)]. The Committed Effective Dose Equivalent at the location of maximum dose from all operational tests was calculated to be 8.6 millirem, and the maximum total organ dose (thyroid) was calculated to be 21 millirem.

(U) The estimated risk applied at the location of maximum offsite dose, from routine test facilities operations are 7 x 10^{-6} latent cancer fatalities and 2 x 10^{-6} genetic defects. That is to say, the maximally exposed individual would face an increased risk (above the already existing risk of 2.2 x 10^{-1}) of dying of cancer of 7 x 10^{-6}. This same individual would face an increased risk (above the already existing risk of 2.0 x 10^{-2}) of producing offspring with genetic defects of 2 x 10^{-6}.

(U) There are no differences between proposed locations or sites with respect to maximally exposed individual exposures.

Population (U)

(U) The population doses are summarized in Table 4.4-2 for the population 80 kilometers (50 mi) downwind of the INEL sites.

(U) The Collective Committed Effective Dose Equivalent received from routine operational releases from the test facilities by the downwind population within 80 kilometers (50 mi) of QUEST was calculated to be 8 to 11 person-mrem from the PIPET and mini-GTA tests for the range of downwind populations. Since the test event would be a relatively short period of time, the wind is assumed to be blowing in a single direction. Thus, only those individuals downwind (i.e., in that direction) would receive exposures from this source. High population sectors have been eliminated as possible exposure sites, placing an operational limit on testing at this facility. The dose range indicated is for the minimum and maximum population exposures for wind directions considered. The GTA Collective Committed Effective Dose Equivalent in the same population was calculated to be 150 to 170 person-mrem. The Collective Committed Effective Dose Equivalent received by the population for routine operational releases from QTA test was calculated to be 1300 to 2300 person-mrem. The population dose from all operational tests at the proposed test facility was calculated to be 4500 to 6200 person-mrem, spread over a period of about 4 years. The number of health effects expected to occur in this population as a result of routine operations of the test facility would be 4 x 10^{-3} to 5 x 10^{-3} latent cancer fatalities and 1 x 10^{-3} to 2 x 10^{-3} genetic disorders. That is to say, since 22 percent of the affected population of 127,494 (28,049 individuals) are ordinarily expected to die from cancer (Krieger, 1991), the performance of ground testing activities would add only 4 x 10^{-3} to 5 x 10^{-3} cancer fatalities to this for an expected cancer fatality total of 28,049.0045. This same population would ordinarily be expected to produce 2 percent of its offspring (or 2,550 individuals) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 1 x 10^{-3} to 2 x 10^{-3} additional genetic disorder cases to the offspring of the entire population from normal operations.

TABLE 4.4-2: COLLECTIVE POPULATION DOSE FROM ROUTINE OPERATIONS AT QUEST[1] (U)

Operations	Committed Effective Dose Equivalent (person-mrem)	
	Minimum[2]	Maximum[2]
PIPET, Mini-GTA	8.0×10^{0}	1.1×10^{1}
GTA, #1, #2, etc.	1.5×10^{2}	1.7×10^{2}
QTA	1.3×10^{3}	2.3×10^{3}
Total[3]	4.5×10^{3}	6.2×10^{3}

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[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) Downwind population dose (including ingestion pathways and 1 day holdup and release of noble gases and halogens); restricting heavily populated sectors from consideration (winds approximately toward 22.5° clockwise through 212.5°).

[3] (U) The total collective population dose equivalent represents the dose equivalent to the population within an 80 kilometer (50 mi) radius of QUEST from all operational releases over the length of the test period (i.e., spread over about 4 years).

Routine Transportation (U)

(U) The risks of transportation of radioactive material and waste to and from the proposed test facilities at INEL were determined using the same methodologies as in Section 4.3.4.2.3 and Appendix A. The incident-free population dose to the population along the shipping routes was calculated to be 140 person-rem from material shipped to and from the proposed test facility. The risk of radiation induced health effects for the population was calculated to be 6.9 x 10^{-2} and 2.8 x 10^{-2} latent cancer fatalities and genetic disorders, respectively.

4.4.4.2.2 Postulated Facility Accidents (U)

Introduction (U)

(U) The postulated accident scenarios are the same as those presented in Section 4.3.4.2.2. The plume power, release fractions, release time, and fission product inventory are the same at QUEST as at the SMTS (see Section 4.3.4.2.2). The same meteorology assumptions were used in this analysis.

Consequences at the Location of Maximum Dose Due to Bounding Case Accidents (U)

(U) Radiation exposures to the maximum offsite individual are summarized in Table 4.4-3. The maximum Committed Effective Dose Equivalent resulting from a PIPET or Mini-GTA accident is 20 millirem at 34 km (21 mi). The maximum organ dose is 22 millirem to the bone surface at 34 km (21 mi). For the GTA (bounding case accident) the CEDE is 130 millirem and the maximum organ dose (to the bone surface) is 150 millirem, both at 34 kilometers (21 mi). The anticipated health effects from the bounding case accident are 1 x 10^{-4} latent cancer fatalities and 3 x 10^{-5} genetic defects. That is to say, the maximally exposed individual would face an increased risk of dying of cancer of 1 x 10^{-4}. This same individual would face an increased risk of producing offspring with genetic defects of 3 x 10^{-5}.

(U) There are no differences between proposed locations or sites with respect to maximally exposed individual exposures.

Population (U)

(U) Population dose from postulated accidents are presented in Table 4.4-3. The Collective Committed Effective Dose Equivalent to the downwind population residing within 80 kilometers (50 mi) of the bounding case accident scenario was calculated to be 4,200 to 8,000 person-mrem from an accident during PIPET or mini-GTA. If an accident occurred during the GTA or QTA tests, the Collective CEDE was calculated to be 35,000 to 62,000 person-mrem. As discussed previously, the operation of the test facilities would be dependent on the wind direction, wind speed, and other meteorological conditions. If the test systems are only operating when the wind is to the north, the collective whole body dose would be substantially lower, since fewer people reside north of the INEL (i.e., Idaho Falls would not be included). The additional cancer fatalities and additional genetic disorders expected to be caused by the bounding case accident

TABLE 4.4-3:
COMMITTED EFFECTIVE DOSE EQUIVALENT AT THE LOCATION OF MAXIMUM OFFSITE DOSE AND COLLECTIVE POPULATION DOSE FROM ACCIDENTS AT QUEST[1] (U)

Maximum Individual:

Test System	Highest Organ	Maximum Committed Organ Dose (mrem)	Distance (km)	Committed Effective Dose Equivalent (mrem)	Distance (km)
PIPET, Mini-GTA	Bone Surface	2.2×10^1	34	2.0×10^1	34
GTA and QTA	Bone Surface	1.5×10^2	34	1.3×10^2	34

Population:

Test System	Committed Effective Dose Equivalent (person-mrem)	
	Minimum[2]	Maximum[2]
PIPET, Mini-GTA	4.2×10^3	8.0×10^3
GTA and QTA	3.5×10^4	6.2×10^4

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[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) Downwind population dose; restricting heavily populated sectors from consideration (winds approximately toward 22.5° clockwise through 212.5°).

scenario would be 3×10^{-2} to 5×10^{-2} and 9×10^{-3} to 2×10^{-2}, respectively. That is to say, since 22 percent of the affected population of 127,494 (28,049 individuals) are ordinarily expected to die from cancer (Krieger, 1991), the performance of ground testing activities would add only 3×10^{-2} to 5×10^{-2} cancer fatalities to this for an expected cancer fatality total of 28,049.04. This same population would ordinarily be expected to produce 2 percent of its offspring (or 2,550 individual) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 9×10^{-3} to 2×10^{-2} additional genetic disorder cases to the offspring of the entire population from a bounding case accident.

4.4.4.2.3 Transportation Accidents (U)

([redacted]) The [redacted] project requires shipment of unirradiated and irradiated, enriched uranium bearing fuel, fuel samples, fuel elements, fuel assemblies, and complete test articles. Uranium-bearing low-level and TRU radioactive and radioactive mixed wastes are also included.

(U) If the site selected were INEL rather than NTS, the impact of transportation accidents would be quite similar to those predicted for activities at the NTS. The radiological risk for possible transportation accidents would be 7.3×10^{-7} latent cancer fatalities and genetic defects compared to 5.1×10^{-7} for NTS; the non-radiological risk (probability of a single traffic death due to vehicle accident) for shipments was estimated to be 0.24 compared to 0.21 for shipping to NTS.

4.4.4.3 Projected Doses (U)

(U) A summary of the projected doses at program model conditions is compared to the standards below:

PIPET/Mini-GTA (U)

(U) Current radiological impact assessments indicate that normal operation of PIPET/Mini-GTA would be below the 10 mrem/year NESHAP standard. The controlled element failure test is predicted to be below the NESHAP limit. PIPET/Mini-GTA accident impacts would be below the ANSI/ANS 15.7 limit.

GTA (U)

(U) GTA normal operations do not exceed the NESHAP limit. For the GTA accident, the ANSI/ANS 15.7 limit would not be exceeded.

QTA (U)

(U) Operation of the QTA at expected power levels without an ETS would result in a dose that does not exceed the standards for both the operation and accident case.

Synopsis (U)

(U) Because the predicted radiological effects of ground testing and transporting of radiological materials as well as the radiological effects of the bounding case accident are sufficiently low that increased health effects are not expected, the impact of radiological emissions on the environment is negligible. Therefore, the environmental consequences would be insignificant.

4.4.5 Summary of Environmental Consequences at QUEST (U)

(U) Noise is the only area that has a potential for high impact and potentially significant environmental consequences at QUEST. However, since members of the general public would not be exposed to these noise levels, and since the few workers (five) in the area during testing operations would be subject to the protective measures discussed, the environmental consequences of noise would be insignificant. Although there would be a potential for moderate impacts and potentially significant environmental consequences to site workers as a result of the storage and handling of process fluids, the measures discussed above would reduce the probability of an accident to very low levels and result in insignificant environmental consequences. Because the site would be far removed from the general public, there would not be effects to public health and safety.

(U) There would be a potential for low impacts for waste at QUEST. Waste would be processed within the existing INEL process streams and within compliance of all existing environmental regulations. Environmental consequences would, therefore, be insignificant. Impacts to land use and infrastructure also would be low because of grazing restrictions and the closing of public roadways during testing operations, respectively. Impacts to land use would be low since the amount of land removed from grazing would be a very small percentage of the total grazing land available at INEL. Closing the public roads would be temporary, infrequent, and of short duration. Impacts to land use and infrastructure would be low and therefore the environmental consequences would be insignificant.

(U) Cultural and biological impacts are rated low pending a detailed cultural and biological resources survey of the QUEST site. Prior to any construction activities, cultural and biological survey would be conducted and the appropriate agencies would be consulted. Environmental consequences, therefore, would be insignificant.

(U) Radiological impacts would be negligible at QUEST. Analysis of the radiological dose from the facility indicates that the estimated risk of additional latent cancer deaths and genetic defects are sufficiently small that no health effects (anticipated cancer deaths or genetic defects as a result of routine operations or an accident) would be expected from radiation exposure at the program model conditions or at applicable standards. Environmental consequences, therefore, would be insignificant.

4.5 LOFT SITE - IDAHO NATIONAL ENGINEERING LABORATORY (INEL) (U)

(U) This section discusses the expected environmental consequences of constructing and operating the proposed ground test facility at the LOFT Site at INEL. The discussion includes potential non-radiological and radiological impacts that result from routine operations and as a result of abnormal events or accidents.

(U) The environmental consequences of locating the ground test facility at the LOFT Site are based on the same atmospheric emissions, liquid effluents, solid wastes, and radiological source terms for normal and accidental releases previously discussed in Sections 4.3 and 4.4.

([redacted]) There are existing facilities that can be used at the LOFT site for [redacted] Program activities. Therefore, construction activities at the LOFT site would primarily involve modification of the existing facilities and installation of storage tanks, process fluids distribution system, an ETS and a flare stack. All construction is expected to occur within areas previously fenced and set aside for development, testing and operations.

(U) The normal operational impacts associated with locating the ground test facility at the INEL-LOFT site would be similar to those described for locating the project at the INEL-QUEST site. The following sections describe the impacts associated with locating the ground test facility at the LOFT site:

4.5.1 Socioeconomics (U)

4.5.1.1 Population and Economy (U)

(U) The impacts of modifying the LOFT site would be expected to be less than those described in Section 4.4.1.1. The construction workforce would be smaller because less construction at the LOFT site is required. None of the workforce would be immigrating into the region due to the availability of construction craft workers that have been involved in other construction projects at INEL. Because no additional demand would be placed on services and facilities, the impacts of the modification of the LOFT facility on the population and economy would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Operation of the ground test facility at LOFT would require the same number of personnel (60) as would operations of the proposed SMTS or QUEST facilities. The 60 extra personnel required for operation of the LOFT facility represents less than 0.5 percent of the INEL workforce and would place no additional demand on services and facilities. Thus, operation of the ground test facility at LOFT would have a negligible impact on the population and economy. Therefore, the environmental consequences would be insignificant.

4.5.1.2 Land Use and Infrastructure (U)

(U) The land area that would be affected at the LOFT site has existing facilities. Approximately 20 hectares (50 acres) of additional expansion would be required. This represents less than 0.01 percent of the land area of INEL.

(U) Impacts to land use and infrastructure from modifying the LOFT site would be lower than the impacts for constructing QUEST because the LOFT site was at one time an operational test facility. A water system, sewage system and power lines are already in place. No additional infrastructure would be required to support the proposed action. Since the expansion of the LOFT facility would be compatible with existing land use, would cause only a minor reduction in the supply of vacant land, and would not require additional equipment or facilities, the impact of construction on land use and infrastructure would be low and the environmental consequences would be insignificant.

(U) As described for QUEST, the operation of the ground test facility at LOFT might preclude the use of land for other activities. Although, LOFT is used exclusively for nuclear testing, the modification of the containment facility may preclude its use for conventional future nuclear testing. A major non-radiological accident could preclude the use of LOFT for several months or years until the facility could be reconstructed. Areas to the east of LOFT are used as grazing land but, as discussed for the QUEST site, would be affected very little by operations at LOFT. Mitigation to reduce the possibility of accidents are described in Sections 4.3.1.5 and 4.5.1.5. Operations would cause little change in land use, the impact of operations on land use would be low. Because the proposed action is compatible with the nuclear research objectives of LOFT, the impact would be low and the environmental consequences would be insignificant.

(U) The operations at LOFT would not require additional equipment or facilities. However, as at QUEST, testing may require the temporary closing of public roads within 15 km (9 mi) of the ground test facility but within the favorable winds testing zone (212.5° clockwise to 22.5°). This would include portions of State Roads 22, 28 and 33. The average daily traffic on the affected portions of these roads are 376, 1120, and 1170, respectively (DOE, 1991a). Closing these roads would cause a disruption in traffic through the INEL. This disruption would be temporary, infrequent, and of short duration. Since operations at LOFT would require some changes in operational practices as well as cause some degradation of existing service, the impact of operations on infrastructure would be low. Because of the short duration and infrequent occurrence of the testing operation as well as the availability of alternative routes, the impact would be low and the environmental consequences would be insignificant. Although the impact would be insignificant, the disruption could be minimized by scheduling testing at projected low traffic use periods.

4.5.1.3 Noise[1] (U)

(U) Because less construction is required, noise impacts for the construction of the LOFT site would be at the same level as at QUEST (90 dBA) but for shorter durations. Non-project related personnel at INEL would not be affected by the construction noise. The distance from LOFT to the main road is 3 km (2 mi). Sensitive receptors outside INEL are not likely to experience any noticeable increase in noise levels because of the long distance from the LOFT site to the nearest INEL boundaries. The nearest community is 18 km (11 mi) away. Mitigation

[1] (U) Noise effects on fauna are addressed in Section 4.3.3.

for on-site personnel includes following OSHA workplace noise regulation with hearing protection supplied as needed. Because noise would be raised above ambient levels by more than the significance criteria of 35 dBA and could exceed the OSHA 8 hour long-term exposure limit, the impact of construction noise (at the project site) would be high. Therefore, the environmental consequences would be potentially significant. However, the environmental consequences would be mitigated to insignificant levels as discussed above.

(U) Noise issues associated with testing operations are the same at the LOFT site as at the QUEST site except that the containment facility could be expected to dampen some of the testing noise. As at SMTS and QUEST, mitigation includes sound barriers, hearing protection, and the physical isolation of non-essential personnel from the facility during testing. Sensitive receptors (in the nearest communities) would not be impacted by the noise.

(U) The testing is expected to raise ambient noise levels by more than the high significance criteria of 35 dBA and could exceed the OSHA short-term exposure limit. Therefore, the noise associated with testing activities would have a high impact on noise levels (at the project site). Because there are no sensitive receptors in proximity to the site and hearing protection is required for operations personnel, the environmental consequences would be mitigated to insignificant levels.

4.5.1.4 Historic and Archaeological Resources (U)

(U) Because the LOFT site is located in an area that has been previously disturbed and re-graded, no significant cultural or historic resources are expected. Therefore, the impact of the activities at the LOFT site would be negligible. However, if the site is selected, prior to any construction, consultation with appropriate agencies would take place. If determined to be necessary, a detailed cultural resources survey would be performed and appropriate mitigation measures would be undertaken to ensure that the environmental consequences would be insignificant. Mitigation measures would include: 1) identification and recovery of artifacts; 2) relocation of facilities; and 3) flagging of sites to be left undisturbed.

4.5.1.5 Safety (U)

(U) The design of the test facility at the LOFT site has no unusual features which would increase work hazards during modification. Construction activities would be carried out in compliance with applicable OSHA and DOE regulations. No additional occupational impacts beyond those currently experienced in construction activities at INEL are expected. Therefore, the impact of modifying the LOFT facility on safety would be low but mitigable. Therefore, the environmental consequences would be insignificant.

(U) The safety issues and their impacts at the LOFT site would be identical to those for operations at the QUEST facility except for containment structure safety and flooding hazard which are described below:

Containment Structure Safety (U)

(U) The use of the containment structure for testing purposes would require the inerting and venting of the structure before personnel could enter. An improperly inerted or vented containment structure could pose a danger of deflagration or detonation and/or a danger of asphyxiation. These dangers would be mitigated by the use of hand-held atmospheric detection systems.

(U) Because the use of the containment structure could threaten the physical well-being of workers, its use would have a moderate impact on safety. Therefore, the environmental consequences would be potentially insignificant. The consequences would be reduced to insignificant levels by the implementation of the mitigation discussed above.

Flooding Safety (U)

(U) Flooding of the LOFT facility may be possible under conditions of maximum flows in the Big Lost River and Birch Creek combined with failure of water control structures on these streams. Water depths in the playa would have to exceed 4.5 meters (15 ft) in order to reach LOFT.

(U) The LOFT facility is a Class I facility and hydrologic analyses were performed prior to construction. It is unlikely that a flood could occur that would reach the LOFT facility. Because flooding would pose no danger to personnel, the impact of flooding on safety would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

(U) In general, the activities taking place at LOFT would have a moderate impact on safety and would therefore be potentially environmentally significant. Although there is a potential for moderate impacts to site workers as a result of the storage and handling of process fluids, the mitigation measures discussed would reduce the probability of an accident to very low levels and result in insignificant environmental consequences. Because the site is far removed from the general public, there are no effects to public health and safety.

4.5.1.6 Waste (U)

(U) Because of the smaller scale of activities, facility modification activities would generate smaller quantities of uncompacted nonhazardous wastes than at the SMTS or QUEST sites. Nonradioactive nonhazardous waste would be disposed of in the Central Facilities Area (CFA) Landfill. The amount of waste generated would not significantly impact the CFA Sanitary Landfill. Nonhazardous wastes would be managed in compliance with Subtitle D requirements of RCRA. Sanitary effluents generated during construction would be collected in existing sewer lines and delivered to a water treatment plant located at the facility. Since no changes in operational arrangements are anticipated to handle the waste, the impacts of nonhazardous, nonradioactive waste on waste management would be negligible. Therefore, the environmental consequences would be insignificant.

(U) Wastes generated by the ground testing operations at LOFT would be the same as those for SMTS and QUEST. The wastes would be handled as described in Section 4.4.1.6 for the QUEST facility. In general, the [redacted] activities taking place at LOFT would have a low impact on waste management. Since the wastes generated by the [redacted] program would be managed in accordance with existing waste management procedures which include the protection of the environment, the environmental consequences would be insignificant.

4.5.2 Physical Environment (U)

4.5.2.1 Topography (U)

(U) The expansion of the LOFT facility would require the cutting and filling of about 2,500-3,000 m^3 (3,000-4,000 ft^3). Some alterations of the natural surface drainage could occur as a result of grading. But because the area of impact would be small and because little change would be made to the character of the area, the impact of the modification of LOFT on topography would be negligible. There would be no impacts on topography from operations. Therefore, the environmental consequences would be insignificant.

4.5.2.2 Geology and Soils (U)

(U) As at QUEST, the only geological effects of the modification of the LOFT facility would be some leveling and/or resurfacing of the soils in the immediate area. Dust and soil would be transported by winds during construction activities, but the effect would be local. Removal of vegetation from the modified area would not significantly increase soil erosion from rainfall since the vegetation is sparse. Protection against erosion would include the orientation of the facility parallel to the natural surface features to minimize drainage and erosion impact as well as the application of spray mist water to minimize wind-caused soil erosion.

(U) There are no known paleotological or mineral resources, agricultural soils or construction materials at the LOFT facility area. Because the proposed modification and operation of the LOFT facility would cause no loss or irretrievable commitment of geological or soils resources, the project would have a negligible impact on geology and soils. Therefore, the environmental consequences would be insignificant.

4.5.2.3 Seismic and Volcanic Activity (U)

(U) Because construction and operations would not cause seismic and volcanic activity that would be detectable by humans or instrumentation, the project would have a negligible impact on seismic or volcanic activity. Therefore, the environmental consequences would be insignificant.

4.5.2.4 Water Resources (U)

(U) The water table in the location of the ground test facility, the Snake Plain aquifer, is over 140 m (approx 450 ft) below the earth's surface. Surface water resources in the vicinity of

QUEST include Birch Creek and Big Lost River. Water resources may be affected by water uses and water quality. Each are described below:

Water Use (U)

(U) The volume of water to be used during construction of the ground test facility is approximately 10 percent of that used to build the SMTS or QUEST sites [approximately 6 million liters (2 million gal)]. This water would be supplied from the in-place water supply system. The construction water use represents about 1 part in 1 million of the annual discharge of the aquifer to the Snake River and about 1 part in 300,000 of the volume withdrawn by all users of the eastern Snake River Plain. During operations, an estimated 11 million (3 million gal) would be required per year, also supplied from the in-place water supply system. The construction water use represents about 1 part in 5 million of the annual discharge of the aquifer to the Snake River and about 1 part in 2 million of the volume withdrawn by all users of the eastern Snake River Plain. The proposed construction and annual project water use would represent only 0.5 and 0.1 percent of the volume negotiated in the water rights agreement with the Idaho Department of Water Resources.

(U) No surface water withdrawals or discharges would occur during test facility construction. Because water use would cause no measurable change in the projected baseline water resource system, the impacts of water use on water resources would be negligible. Therefore, the environmental consequences would be insignificant.

Water Quality (U)

(U) As at SMTS, stored water could leak and seep into the water table carrying surface pollutants. Domestic waste would be handled by an existing sewage system. Spills of hazardous substances could introduce pollutants to the ground water table. Because the depth of the water table reduces the potential for seepage into the ground water and because of the lack of surface waters that would be affected, the impacts of waste water on ground water resources would be negligible. Therefore, the environmental consequences would be insignificant.

Synopsis (U)

(U) In general, the use and discharge of water would have a negligible impact on water resources. Because impacts would be negligible and testing operations would be of short duration (approximately four to ten years), environmental consequences would be insignificant.

4.5.2.5 Meteorology and Air Quality (U)

(U) There would be no impacts on meteorology as a result of construction and operation of the ground test facility.

(U) Air quality issues and impacts associated with modification and operation of the LOFT facility would be similar to those affecting the SMTS and QUEST. [See Sections 4.3.1.2.5 and 4.4.1.2.5]. Since modifications of facilities at LOFT would require less construction activity,

construction caused dust and emissions would be less at LOFT than at the other two potential sites. Since emissions would be well below the threshold values and the emissions standards that protect human health and welfare, the impact of the activities at LOFT on meteorology and air quality would be negligible. Therefore, the environmental consequences would be insignificant.

4.5.3 Biological Environment (U)

(U) The same activities as those described for the QUEST site would impact the biological environment at the LOFT site.

4.5.3.1 Terrestrial Biota (U)

(U) The LOFT facility is located within a disturbed area that has been regraded. Plant species include invader species such as rabbit brush as well as saltbrush and Indian ricegrass. The LOFT site is not considered to be an important wildlife habitat because the area has been largely disturbed by previous construction and operation activities.

(U) The same activities that impact terrestrial biological resources during operations at NTS and QUEST would also be an issue at LOFT. The impacts of noise, flaring of hydrogen, hot hydrogen venting and steam releases are discussed in Sections 4.3.3.1 and 4.4.3.1. Mitigations that would help minimize impacts to habitat and wildlife include rescheduling of activities to avoid seasonal sensitivity of a species, limiting the number of personnel in the area, controlling access, and minimizing disturbance to the site. Because LOFT is surrounded by previously disturbed habitat that are of low diversity, the impacts of modification and operation of LOFT on terrestrial biota would be negligible. Therefore, the environmental consequences would be insignificant.

4.5.3.2 Aquatic Biota (U)

(U) Aquatic biota exist in the vicinity of LOFT at Birch Creek and Big Lost River. These biota could be susceptible to activities at LOFT such as the release of beryllium. In the unlikely event of an accident the low concentrations of beryllium released would have little effect on nearby aquatic biota. Because the area supports an aquatic habitat of relatively low diversity and are 1 to 3 km (0.5 - 2 mi) from the LOFT site, the impacts of activities at LOFT would have a negligible impact on aquatic biota. Therefore, the environmental consequences would be insignificant.

4.5.3.3 Threatened and Endangered Species (U)

(U) As explained in Section 4.4.2.3.3, the proposed action would have a negligible impact on threatened and endangered species (i.e. bald eagle and peregrine falcon). Therefore, the environmental consequences would be insignificant.

4.5.4 Radiological Impacts (U)

4.5.4.1 Radiological Impacts During Construction (U)

(U) Prior to modification, radiological monitoring as required by DOE order 5400.1 would be performed at the proposed site to ensure no unacceptable soil contamination exists in the areas to be disturbed. If excess radiological contamination is found, the area would be remediated to acceptable levels before construction begins. Dust control techniques would be used as appropriate, and any contamination present at low levels would be dispersed or settle out before it reaches the INEL site boundary. Offsite exposures from construction activities would, therefore, be negligible. Therefore, the environmental consequences would be insignificant.

4.5.4.2 Radiological Impacts During Operations (U)

4.5.4.2.1 Normal Operations (U)

(U) This section considers the LOFT site. The LOFT site is about 13 kilometers (8 miles) from the nearest INEL site boundary. The population within an 80 kilometer (50 mile) radius of both sites at INEL of 127,494 people was used for this analysis.

(U) The following sections briefly discuss the results of the calculations for locating the test facilities at LOFT. The methodology used to perform these calculations is discussed in Section 4.3.4.2 and Appendix A.

<u>Maximum Offsite Individual Dose</u> (U)

(U) The individual doses associated with normal operations are summarized in Table 4.5-1.

(U) The Committed Effective Dose Equivalent at the location of maximum offsite dose was calculated to be 9.7×10^{-3} millirem [at 46 km (29 mi)] for routine releases from each PIPET or Mini-GTA test. The effective dose equivalent at 46 km (29 mi) from each GTA or QTA test was calculated to be 0.069 millirem. The maximally exposed organ for the PIPET or Mini-GTA tests was the thyroid with a calculated dose of 0.049 millirem [at 187 km (116 mi)]. The GTA or QTA tests resulted in a maximum organ dose (thyroid) of 0.42 millirem at 198 km (123 mi). The Committed Effective Dose Equivalent at the location of maximum dose from all operational tests was calculated to be 8.6 millirem, and the maximum total organ dose (thyroid) was calculated to be 21 millirem.

(U) The estimated risk to the individual applied at the location of maximum offsite dose, from routine test facilities operations are 7×10^{-4} cancer fatalities and 2×10^{-4} genetic defects[2]. That is to say, the maximally exposed individual would face an increased risk (above the already existing risk of 2.2×10^{-1}) of dying of cancer of 7×10^{-4}. This same individual would face an

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[2](U) See Section 4.4.4.2.1 for detailed explanation of values.

TABLE 4.5-1:
INDIVIDUAL DOSES AT THE LOCATION OF MAXIMUM OFFSITE DOSE FROM OPERATIONAL RELEASES FROM EACH TEST AND TOTAL PROGRAM NEAR LOFT[1] (U)

Operation	Organ	Maximum Committed Organ Dose (mrem)	Distance (km)	Committed Effective Dose Equivalent (mrem)	Distance (km)
PIPET, Mini-GTA	Thyroid	4.9×10^{-2}	187	9.7×10^{-3}	46
GTA #1, #2, etc.	Thyroid	4.2×10^{-1}	198	6.9×10^{-2}	46
QTA	Bone Surface	5.4×10^{0}	27	5.9×10^{0}	28
Total[2]	Thyroid	2.1×10^{1}	--	8.6×10^{0}	--
NESHAP[3]	N/A	N/A		10.0	

[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) The total dose is spread over the duration of the project (i.e., about 4 years) and includes all ground testing.

[3] (U) EPA 40 CFR 61, Subpart H limits radiological exposure to the public to 10 millirem/year for each DOE installation like NTS or INEL.

increased risk (above the already existing risk of 2.0×10^{-2}) of producing offspring with genetic defects of 2×10^{-6}. These are the same as the risks for the other alternative sites.

Population (U)

(U) The population dose is the same as presented in Section 4.4.4.2.1. The number of health effects expected to occur in this population as a result of routine operations of the test facility would be 4×10^{-3} to 5×10^{-3} latent cancer fatalities and 1×10^{-3} to 2×10^{-3} genetic disorders. That is to say, since 22 percent of the affected population of 127,494 (28,049 individuals) are ordinarily expected to die from cancer (Krieger, 1991), the performance of ground testing activities would add only 4×10^{-3} to 5×10^{-3} cancer fatalities to this for an expected cancer fatality total of 28,049.0045. This same population would ordinarily be expected to produce 2 percent of its offspring (or 2,550 individuals) with genetic disorders (BEIR, 1990; Colorado, 1989). The proposed program would add 1×10^{-3} to 2×10^{-3} additional genetic disorder cases to the offspring of the entire population from normal operations.

(U) These results are applied to operations at either the QUEST site or the LOFT site. In reality, there may be slight differences in the doses from operations at the two sites due to local topography, meteorology, and demographics. These differences, however, are less than the uncertainties associated with these impact estimations and are neglected in further discussions.

4.5.4.2.2 Postulated Facility Accidents (U)

Introduction (U)

(U) The postulated accident scenarios are the same as those presented in Section 4.3.4.2.2. The plume power, release fractions, release time, and fission product inventory are the same at LOFT as at the SMTS. The same meteorology assumptions were used in this analysis.

Consequences at the Location of Maximum Dose Due to Bounding Case Accidents (U)

(U) Radiation exposures to the maximum offsite individual are summarized in Table 4.5-2. The Committed Effective Dose Equivalent resulting from a PIPET or Mini-GTA accident is 20 millirem at 34 kilometers (21 mi). The maximum organ dose is 22 millirem to the bone surface at 34 kilometers (21 mi). For the GTA or QTA (bounding case accident) the CEDE is 130 millirem at 34 km (21 mi) and the maximum organ does (to the bone surface) is 150 millirem [also at 34 km (21 mi)]. The anticipated health effects from the bounding case accident are 1×10^{-4} latent cancer fatalities and 3×10^{-5} genetic defects.

(U) There are no differences between proposed locations or sites with respect to maximally exposed individual exposures.

Population (U)

(U) Population dose results are the same as presented in Section 4.4.4.2.2.

TABLE 4.5-2: COMMITTED EFFECTIVE DOSE EQUIVALENT AT THE LOCATION OF MAXIMUM OFFSITE DOSE FROM ACCIDENTS AT LOFT[1] (U)

Maximum Individual:

Test System	Highest Organ	Maximum Committed Organ Dose (mrem)	Distance (km)	Committed Effective Dose Equivalent (mrem)	Distance (km)
PIPET, Mini-GTA	Bone Surface	2.2×10^1	34	2.0×10^1	34
GTA and QTA	Bone Surface	1.5×10^2	34	1.3×10^2	34

Population:

Test System	Committed Effective Dose (person-mrem)	
	Minimum[2]	Maximum[2]
PIPET, Mini-GTA	4.2×10^3	8.0×10^3
GTA and QTA	3.5×10^4	6.2×10^4

[1] (U) 2,000 meter (6,600 ft) inversion layer.

[2] (U) Downwind population dose, restricting heavily populated sectors from consideration (winds approximately toward 22.5° clockwise through 212.5°.

4.5.4.2.3 Transportation Accidents (U)

(U) Transportation impacts would be the same as that presented in Section 4.4.4.2.3.

4.5.4.3 Projected Doses (U)

(U) A summary of the projected doses at program model conditions is compared to the standards below:

PIPET/Mini-GTA ([redacted])

(U) Current radiological impact assessments indicate that normal operation of PIPET/Mini-GTA would be below the 10 mrem/year NESHAP standard. The controlled element failure test is predicted to be below the NESHAP limit. PIPET/Mini-GTA accident impacts would be below the ANSI/ANS 15.7 limit.

GTA (U)

(U) GTA normal operations do not exceed the NESHAP limit. For the GTA accident, the ANSI/ANS 15.7 limit would not be exceeded.

QTA (U)

(U) Operation of the QTA at expected power levels without an ETS would result in a dose that does not exceed the standards for both the operation and accident case.

Synopsis (U)

(U) Because the predicted radiological effects of ground testing and transporting of radiological materials as well as the radiological effects of the bounding case accident are sufficiently low that increased health effects are not expected, the impact of radiological emissions on the environment would be negligible. Therefore, the environmental consequences would be insignificant.

4.5.5 Summary of Environmental Consequences at LOFT (U)

(U) Noise is the only area that has a potential for high impact and potentially significant environmental consequences at LOFT. However, since members of the general public would not be exposed to these noise levels, and since the few workers (five) in the area during testing operations would be subject to the protective measures discussed, the environmental consequences of noise would be insignificant. Although there is a potential for moderate impacts to site workers as a result of the storage and handling of process fluids, the measures discussed would reduce the probability of an accident to very low levels and result in insignificant environmental consequences. Because the site is far removed from the general public, there are no effects to public health and safety.

(U) Waste would be processed within the existing INEL process streams and within compliance of all existing environmental regulations. Impacts would be low and environmental consequences would, therefore, be insignificant. Impacts to land use and infrastructure also would be low because of grazing restrictions and the closing of public roadways during testing operations, respectively. Environmental consequences to land use would be insignificant since the amount of land removed from grazing would be a very small percentage of the total grazing land available at INEL. Closing the public roads would be temporary, infrequent, and of short duration. The impacts would be low and environmental consequences would be insignificant.

(U) Radiological impacts would be negligible at LOFT. Analysis of the radiological dose from the facility indicates that the estimated risk of additional latent cancer deaths and genetic defects are sufficiently small that no health effects (anticipated cancer deaths or genetic defects as a result of routine operations or an accident) would be expected from radiation exposure at the program model conditions or at applicable standards. Environmental consequences, therefore, would be insignificant.

[redacted]

4.6 [redacted]

([redacted]) [redacted]

([redacted]) [redacted]

[redacted]

([redacted]) [redacted]

4.6.1 [redacted]

([redacted]) [redacted]

([redacted]) [redacted]

[redacted]

([redacted]) [redacted]

[redacted]

[redacted]

[redacted]

4.6.2 [redacted]

([redacted]) [redacted]

[redacted]

[redacted]

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[1] (U) If more hydrogen fuel were available for detonation, the plume would be even more dispersed than presented in this scenario and disperse the irradiated fuel over an even larger area resulting in even smaller doses.

[redacted]

TABLE 4.6-1:

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

TABLE 4.6-2: [redacted]

4.6.3 [redacted]

([redacted]) [redacted]

[redacted]

4.6.4 [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

4.6.5 Summary ((U)

[redacted]

4.7 ENVIRONMENTAL IMPACTS OF EXTENDING TIME BETWEEN GROUND TESTS (U)

(U) The following section describes the impacts associated with extending the time interval between ground testing activities to reduce the potential impact of radiological dose (this alternative is described in Section 2.6.4.1).

(U) Most test articles would be run multiple times, resulting in a steadily increasing fission product inventory within the fuel in the test article. This effect would be opposed by the normal radiological decay process, which would decrease the fission product inventory following the completion of each test run. Both processes are a complex combination of isotope ingrowth, daughter product production, and decay of radionuclides with diverse decay rates. ORIGEN2 (Croff, 1983) is a computer code used to accurately model radionuclide inventory during and after fission events.

(U) Intuition suggests that increased "cooldown" time between runs would result in a lower radiological dose from normal operations or from a potential accident dispersing the core, due the lower fission product inventory.

(U) To investigate this alternative, analyses were performed (see Appendix A, Section A.4), simulating both PIPET, mini-GTA, and GTA operations and accident conditions and QTA accident conditions. The operations analyses compare the difference in the dose to an individual from normal operations runs separated by one week each (considered to be a practical minimum) and one month each (a reasonable alternative). The results of these comparisons show an insignificant decrease in Committed Effective Dose Equivalent to the offsite individual from the increased time between tests.

(U) These small decreases are due to the fact that a large portion of the fission product decay occurs within the first day following the experimental run. Relatively little decay occurs in the one week to one month time period. Hence, the environmental impacts of adopting this alternative would be very similar to those anticipated from not adopting this alternative.

4.8 CUMULATIVE IMPACTS (U)

(U) Cumulative impacts are the impacts to the environment that would result from the incremental effects of a proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (CEQ 40 CFR 1508.7).

(U) This section identifies and discusses the impacts from continued development of the program including construction and operation of the ground test facility that would be cumulative with the impacts of other activities beyond the site boundaries and beyond the control of site operations. These include 1) impacts of increasing radiation levels, 2) impacts of air pollutant emissions on global conditions, 3) impacts of TRU waste accumulation, 4) impacts of water use, and 5) reduction of bird habitat.

Cumulative Radiological Effects--NTS (U)

(U) The Effective Dose Equivalent (EDE) for all radioactive releases from the entire NTS site in 1989 to the maximally exposed individual was reported as 1.5×10^{-4} millirem to the whole body (DOE, 1990a). [This translates to a an increased risk (above the already existing risk of 2.2×10^{-1}) of dying of cancer of 1×10^{-10} and an increased risk (above the already existing risk of 2.5×10^{-2}) of producing offspring with genetic disorders of 4×10^{-11}]. Natural background radiation (that from cosmic, terrestrial, world-wide fallout, medical x-rays, and consumer products) contribute an additional 67 millirem per year[1] to the maximally exposed individual in the vicinity of NTS (DOE, 1990a).

(U) Routine operations of the proposed test facilities at NTS would add an additional 8.6 millirem (CEDE) exposure over about a 4 year period (2.1 millirem/year). This translates to an increased risk (above the already existing risk of 2.2×10^{-1}) of dying of cancer of 1×10^{-10} and an increased risk (above the already existing risk of 2.5×10^{-2}) of producing offspring with genetic disorders of 4×10^{-11}. The total radiation exposure to the maximally exposed individual in the vicinity of NTS from all sources of radiation, including the proposed test facilities, would be about 69 millirem per year.

Cumulative Radiological Effects--INEL (U)

(U) The cumulative doses for all radioactive releases from the entire INEL site in 1987 to the maximally exposed individual were reported as less than 0.1 millirem to the whole body (DOE, 1988a). The EDE was reported as 0.005 millirem. Natural background radiation contributes an additional 144 millirem per year[2] to the average individual in the vicinity of INEL (DOE, 1988a).

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[1](U) This naturally occurring background radiation contributes to the existing risk of cancer (2.2×10^{-1}) and genetic defects (2.5×10^{-2}).

[2](U) This naturally occurring background radiation contributes to the existing risk of cancer (2.2×10^{-1}) and genetic defects (2.0×10^{-2}).

(U) Routine operations to the proposed test facilities at INEL would add an additional 8.6 millirem (2.1 millirem/year) to the maximally exposed individual if located at the QUEST or LOFT site. This translates to an increased risk (above the already existing risk of 2.2×10^{-1}) of dying of cancer of 1×10^{-10} and an increased risk (above the already existing risk of 2.0×10^{-2}) of producing offspring with genetic disorders of 4×10^{-11}. The total radiation exposure to the maximally exposed individual in the vicinity of INEL from all sources of radiation, including the proposed test facilities would be about 146.1 millirem per year.

([redacted]) At both the NTS and INEL, the resulting increase in radiation due to normal operations represents a small percentage of the natural background and other radiation sources that the average individual would be exposed to. Therefore, the resulting cumulative impact is anticipated to be not significant. The operational doses are based on present understanding of release fractions that will be further defined by the [redacted] test program and are likely to be modified. Updated dose calculations following operation of the ground test facility should be compared with facility release levels and background levels to determine if there would be a change in the resulting cumulative impact.

<u>Cumulative Atmospheric Emissions</u> (U)

(U) The release of certain trace gases into the atmosphere has potential consequences on global conditions. Gases that are strong absorbers of infrared radiation, such as carbon dioxide, are known as "greenhouse" gases - a reference to their ability to contribute to global warming, or the greenhouse effect. Other greenhouse gases are methane, nitrous oxide, chlorofluorocarbons, Halon-1301, and tropospheric ozone (ozone at the earth's surface). Increases in atmospheric concentrations of these gases from combustion of fossil fuels, of synthetic chemicals, biomass burning, and deforestation have the potential to increase global temperatures. Potential global warming of the surface air temperature by 1.5-4.5° C has been predicted as a result of a projected doubling of the current concentrations of carbon dioxide in the atmosphere. The combined warming and thermal radiation effects of other greenhouse gases could potentially be as large as that from carbon dioxide (DOE, 1991a).

(U) Several of the chemicals that are potential contributors to global warming, as well as chlorofluorocarbons, have been implicated in depletion of the stratospheric ozone, a triatomic molecule of oxygen (O_3). Ozone in the stratosphere [the region 20-35 km (12-22 mi) above the earth's surface] absorbs short-wavelength ultraviolet solar radiation that can be harmful to human health (e.g. skin cancer) and to plant and animal life. Ozone is maintained by a balance of photochemical processes that can be disrupted by the introduction of chlorine, nitrogen, and other catalysts (DOE, 1991a).

(U) Construction and operation of the proposed ground test facility at SMTS, QUEST or LOFT would produce trace gases from combustion of fossil fuels from mobile sources and fossil fuel power generation and from release of process chemicals during routine operations. The maximum power available from the NTS grid for use at the SMTS for operations would be 1.2 megawatts (electric). Since the electrical requirement for operation of the test facility at SMTS would require additional capacity, temporary fossil-fueled power generation units may be required, which could produce up to 10,000 tons/year of carbon dioxide. There would also be

emissions of carbon dioxide as a result of construction of the ground test facility. The cumulative effect of the test facility operations would be to slightly increase the potential rate of global warming discussed earlier.

(U) The operations of [redacted] support facilities may involve the release of small amounts of ozone-depleting gases such as TCA (trichloroethane) and TCE (trichloroethylene). However, the production of these gases could be phased out in the early 2000s. The chemical industry is currently developing substitute materials to replace the chlorofluorocarbons. When suitable substitutes become available, the ozone-depleting gases would be replaced in [redacted] operations. Even if they were not replaced, the ozone-depleting gases produced by [redacted] operations would constitute only a very small fraction of the approximately 400,000 tons of chlorofluorocarbons produced yearly in the United States (Piccot and Saeger, 1990).

<u>Accumulation of TRU Waste</u> (U)

([redacted]) Transuranic (TRU) waste from [redacted] program activities are not anticipated to exceed 30 m^3 (1000 ft^3). TRU wastes would be packaged, certified, and stored at NTS or INEL, pending later shipment to WIPP. The handling procedures and storage capacities at both NTS and INEL can accommodate the volume of TRU wastes generated by the [redacted] program. However, although this volume would be relatively small when compared to the total amount of TRU wastes generated nation wide, it would add to the growing volume that would continue to accumulate until the WIPP facility is available for storage sometime in the future.

<u>Cumulative Water Use</u> (U)

(U) <u>NTS</u>: Ground water appropriation for areas surrounding the NTS is regulated by the Office of the State Engineer and the Division of Water Resources. Local ground water supply problems that have been identified include, but are not limited to the Amargosa Valley, Oasis Valley, and Indian Springs Valley. The construction and operation of the ground test facility at SMTS would require approximately 60 million liters (16 million gallons) and 11 million liters (3 million gallons) per year, respectively. Although these quantities are relatively small in comparison to water requirements for irrigation and larger facilities, there could be a cumulative impact on the Ash Meadows subbasin as a result of all NTS activities including the SMTS. The potential for a cumulative impact would increase if any additional facilities were constructed within the general vicinity. Water use in excess of the perennial yield of the Ash Meadows subbasin, measured by a decrease in the static water level, would result in regulation by the state (i.e. designation order).

(U) <u>INEL</u>: All the water used at INEL is withdrawn from the Snake River Plain aquifer. Current water use at INEL [0.25 m^3/s (9 ft^3/s) or 17.9 million m^3/yr (280 million m^3/yr)] represents only 0.4% of the 63 m^3/s (2,220 ft^3/s) or 2.0 billion m^3/yr (7.0 billion ft^3/yr) of groundwater withdrawn by all users from the aquifer in the Eastern Snake River Plain (ESRP). Most of the water withdrawn from the ESRP is used for agriculture. The INEL operations office has negotiated with the Idaho Department of Natural Resources regarding a claimed water right for 2.3 m^3/s (82 ft^3/s) [not to exceed 43 million m^3/yr (1.5 billion m^3/yr)] withdrawal capacity under the Federal Reserve Doctrine. The construction and operation requirements of

the ground test facility at INEL would require 60,000 m³/yr and 11,000 m³/yr, respectively. This represents 0.14% and 0.03% of the remaining capacity for ground water use and 0.75% and 0.13% of the current usage at the INEL. Although the potential for construction of the New Production Reactor (NPR) at INEL would strain the current allocation for water withdrawal at INEL, the effect of this ground test facility can still be considered negligible (Nelson, 1991b).

<u>Cumulative Bird Habitat Loss</u> (U)

(U) Species of special concern are listed by federal or state authorities in order to protect the species and their habitats. These species may be rare, localized in distribution, and/or vulnerable to human disturbance. Reduction in population numbers of these species may be due to the cumulative effect of many small, insignificant impacts from many sources.

(U) At INEL, species of special concern include open-country birds. In general, undisturbed, native grasslands and desert shrublands that serve as habitat for these species have been greatly reduced due to agricultural use, urban development, and fire. However, the INEL represents large blocks of relatively undisturbed native grassland and desert scrubland that are largely protected from agriculture and other forms of human disturbance. Industrial development is also controlled and represents less than 5% of the total areas of the sites. Thus, INEL affords excellent habitat for open-country species that are under threat from habitat loss at other locations.

(U) Construction and operation of the ground test facility at the INEL - QUEST site would result in a reduction of habitat for the bald eagle and the peregrine falcon which are federally listed threatened and endangered species. Construction and operation of the ground test facility at the INEL QUEST site could also disturb some nesting and foraging habitat for the Swainson's hawk (Federal Category 2 candidate species) and foraging and nesting habitat of the ferruginous hawk (Federal Category 2 candidate). Furthermore, nesting birds might be disturbed during [redacted] construction. If the INEL were selected as the host installation, and biological resource surveys identified any threatened or endangered species, consultation with the Fish and Wildlife Service would take place prior to any construction activities. Seasonal construction requirements as a mitigation measure would depend on the outcome of the consultation with the Fish and Wildlife Service. An additional mitigation measure would be the construction of artificial nest sites to compensate for any removed during constuction. If construction occurred in the vicinity of nesting sites, mitigation measures would be developed in consultation with the Fish and Wildlife Service (DOE, 1991a).

[redacted]

4.9 EMERGENCY PREPAREDNESS (U)

(U) The DOE has issued a series of orders specifying the requirements for emergency preparedness (DOE 5500.1A, DOE 5500.2A, DOE 5500.3, draft DOE 5500.3A, DOE 5500.4, and DOE 5500.9), and each DOE installation has established an emergency management program. These programs are developed and maintained to ensure adequate response for most accident conditions and to provide the framework to readily extend response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with planning, preparedness, and response. Officials at each installation have issued orders specifying the emergency preparedness requirements for the DOE facilities under their jurisdiction (DOE, 1991a).

(U) Emergency preparedness requirements for INEL are specified by the DOE Idaho Operations Office in DOD Orders 5500.2 and 5500.4. The emergency preparedness requirements for the NTS are specified by the DOE Nevada Operations Office as per the DOE Order 5500 series and the "DOE/NV Emergency Preparedness Plan." All existing facilities have emergency plans and procedures that either implement the DOE and site requirements or are integrated with the site planning. If either DOE site were selected for construction and operation of the ground test facility, that site's emergency preparedness requirements would be revised to include the [redacted] facility.

(U) Based on existing requirements and plans, the following procedures would be implemented for [redacted] emergency planning. The [redacted] facility would list and assess the hazards and potential accidents associated with each facility, operation, and activity. An emergency planning zone would be identified for each operation, and activity at the ground test facility. Special planning and preparedness efforts would be required for that zone to ensure that prompt and effective protective actions could be taken to minimize the risk to on-site personnel, the general public, and the environment in the event of an emergency. Procedures would be developed to implement the emergency plan. An emergency response organization would be established and maintained. The organization would consist of experienced and trained personnel responsible for timely emergency response functions. The emergency response activities and the day-to-day duties and responsibilities of the personnel would be correlated (DOE, 1991a).

[redacted]

4.10 SUMMARY OF UNAVOIDABLE ENVIRONMENTAL IMPACTS (U)

(U) Siting, construction and operation of the [redacted] program would result in some impacts to the environment. Most of these could be eliminated, avoided or reduced to insignificant levels by changes in project design or other mitigation measures. There are some impacts, however, that cannot be avoided if the proposed action is to be implemented.

(U) Up to 40 hectares (100 acres) of land would be required for construction and operation of the [redacted] ground test facility. This land would be unavailable for other uses for the duration of the [redacted] program. Following completion of the program, the facilities would be decontaminated and decommissioned and would be available for use by other testing programs.

(U) Construction of the [redacted] facility would result in the loss of wildlife habitat, destruction of vegetation, and displacement of wildlife. This would be minimized to the extent practicable by coordinating project schedules with migratory and breeding patterns and transplanting those plants suitable for landscaping purposes.

([redacted]) Noise would be unavoidable during all ground tests at SMTS, QUEST, and LOFT. The noise generated would be mitigated for [redacted] personnel in the area by adhering to OSHA noise protection standards and poses no problem to offsite population. The departure of some nearby wildlife from their habitat would occur during the tests. It is expected, however that they would return following the tests.

([redacted]) Radioactive, mixed, hazardous and some TRU wastes would be generated by the [redacted] program. Although these wastes can be handled with existing facilities and procedures, the land required for their disposal would be unavailable for other uses.

([redacted]) Unavoidable radiation exposure would include increased occupational exposures and exposures to the general public from normal operations. Consideration of meteorological conditions, materials composition, and ETS design would keep these exposures well below acceptable standards. Preparation of the PSAR and FSAR would ensure that the [redacted] program can and would adhere to these standards prior to the commencement of any tests.

(U) In the unlikely event of an accident at the [redacted] facility, there would be a possibility that a portion of the land on the NTS or the INEL would be unavailable for use because of contamination. This would include some grazing land (at INEL).

4.11 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES (U)

([redacted]) The irreversible or irretrievable commitment of resources for the [redacted] program includes the land required for the disposal of hazardous and radioactive waste. LLW is currently disposed of primarily at the WMU 3 and 5 of the NTS or at the Subsurface Disposal Area of the RMWC at INEL. In the unlikely event of an accident, additional land could be lost as a result of the contamination of soil from radioactive releases. In either case, the unavailability of land would be restricted to NTS and INEL for the most part and would preclude the use of land for testing programs and activities normally conducted there.

([redacted]) Construction materials as well as materials and chemicals used in the [redacted] testing program also would be irretrievable. This includes the 11,000,000 liters (3,000,000 gallons) of water used per year for operation that may have to be treated to remove the radiological materials then released as steam or discharged to the sanitary sewer system (if water is selected as the coolant for the ETS). None of the materials or chemicals required for the construction or operation of the [redacted] program are in short supply and their use would not affect local or national supplies.

4.12 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY (U)

(U) The short-term effects of the construction and operation of the [redacted] program would be the removal of land from other research or testing uses commonly conducted on the NTS and INEL installations. Terrestrial habitat would also be lost on the 40 hectares (100 acres) required for the facility and wildlife would be temporarily disturbed during testing activities. Land would also be unavailable for other uses as a result of the disposal of hazardous and radioactive wastes. The short-term use of the land would be negligible, however, since none of the alternative sites are used for any other purposes nor are there any plans for their use for the duration of the [redacted] program. There would also be short-term use of additional energy to support testing activities of the [redacted] program. Although this use would be minimized through the implementation of conservation methods, the details of the methods cannot be defined at this time because of the developmental nature of the program. An analysis of the conservation potential of various alternatives would be performed as additional information is developed.

(U) Long-term productivity includes the potential for the [redacted] facilities to be used for other testing programs following decontamination and decommissioning. In addition to providing long-term improvements to national defense capability, the technological advances achieved through the [redacted] program may contribute to significant advances in space exploration far into the future.

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ACRONYMS (U)

[redacted]

ACRR	-	Annular Core Research Reactor (U)
AEDC	-	Arnold Engineering Development Center (U)
ALAD	-	Air-Research Los Angeles Division (U)
ALARA	-	As Low As Reasonably Achievable (U)
[redacted]		
ANL-W	-	Argonne National Laboratory West (U)
ANS	-	American Nuclear Society (U)
AQCR	-	Air Quality Control Region (U)
AQO	-	Air Quality Officer (U)
ARAC	-	Atmospheric Analysis Code (U)
ASN	-	Air Sampling Network (U)
ASME	-	American Society of Mechanical Engineers (U)
ATR	-	Advance Test Reactor (U)
B&W	-	Babcock & Wilcox (U)
BECAMP	-	Basic Environmental Compliance and Monitoring Program (U)
BLM	-	Bureau of Land Management (U)
BNL	-	Brookhaven National Laboratory (U)
BWMF	-	Bulk Waste Management Facility (U)
CAA	-	Clear Air Act (U)
CEDE	-	Committed Effective Dose Equivalents (U)
CEQ	-	Council on Environmental Quality (U)
CERCLA	-	Comprehensive Environmental Response Compensation and Liability Act (U)
CFA	-	Central Facility Area (U)
CFCs	-	Chlorofluorocarbons (U)
CFR	-	Code of Federal Regulations (U)
CGA	-	Compressed Gas Association
CH	-	Contact Handled (U)
CWA	-	Clean Water Act (U)
CX	-	Critical Experiment (U)
D&D	-	Decontamination & Decommissioning (U)
DAC	-	Derived Air Concentration (U)
DAS	-	Data Acquisition System (U)
dBA	-	Decibel (U)
DCGs	-	Derived Concentrated Guides (U)
DMSS	-	Dames & Moore Special Service (U)
DOD	-	Department of Defense (U)
DOE	-	Department of Energy (U)
DOI	-	Department of Interior (U)
DOT	-	Department of Transportation (U)
DPM	-	Disintegration Per Minute (U)
DRI	-	Desert Research Institute (U)
EA	-	Environmental Assessments (U)

EBR	-	Experimental Breeder Reactor (U)
EDE	-	Effective Dose Equivalents (U)
ESFs	-	Engineering Safety Features (U)
EIS	-	Environmental Impact Statement (U)
EIT	-	Engine Integration Test (U)
EM	-	Environmental Restoration and Waste Management (U)
EMSL	-	Environmental Monitoring Systems Laboratory (U)
EPA	-	Environmental Protection Agency (U)
ESD	-	Environmental Science Department (U)
ESRP	-	Eastern Snake River Plain (U)
ER	-	Environmental Report (U)
ETS	-	Effluent Treatment System (U)
FIFRA	-	Federal Insecticide, Fungicide, and Rodent Act (U)
FLPMA	-	Federal Land Policy and Mangement Act (U)
GCD	-	Greater Confinement Disposal (U)
GFSD	-	Garrett Fluid Systems Division (U)
GH_2	-	Gaseous Hydrogen (U)
GPALS	-	Global Protection Against Limited Strikes (U)
GSED	-	Grumman Systems Electronics Division (U)
GTA	-	Ground Test Article (U)
GTF	-	Ground Test Facilities (U)
GTS	-	Ground Test Station (U)
GW	-	Gigawatts (U)
HHGG	-	Hot Hydrogen Gas Generator (U)
HMTA	-	Hexamethylene Tetramine (U)
HVAC	-	Heating, Ventilation, and Air Conditioning (U)
HEPA	-	High Efficiency Particulate Air (U)
ICPP	-	Idaho Chemical Processing Plant (U)
ICRP	-	International Commission on Radiological Protection (U)
ICS	-	Integrated Control System(U)
INEL	-	Idaho National Engineering Laboratory (U)
IS	-	International Systems (U)
ISP	-	Specific Impulse (U)
ISZ	-	Idaho Seismic Zone (U)
K	-	Kelvin (U)
kV	-	Kilovolt (U)
kPa	-	Kilopascals (U)
LANL	-	Los Alamos National Laboratory (U)
LDR	-	Land Disposal Restrictions (U)
LER	-	License Evaluation Request (U)
LET	-	Linear-Energy-Transfer (U)
LH_2	-	Liquid Hydrogen (U)
LLNL	-	Lawrence Livermore National Laboratory (U)
LLW	-	Low Level Wastes (U)

[redacted]

[redacted]

LPS	-	Limited Protection System (U)
LSA	-	Low Specific Activity (U)
LTC	-	Lynchburg Technology Center (U)
MACCS	-	MELCOR Accident Consequence Code System (U)
MCL	-	Maximum Contaminant Level (U)
MPa	-	Megapascals (U)
MW	-	Megawatts (U)
MWMU	-	Mixed Waste Management Unit (U)
NAEG	-	Nevada Applied Ecology Group (U)
NASA	-	National Aeronautics and Space Administration (U)
NCRP	-	National Council on Radiation Protection (U)
NDEP	-	Nevada Department of Environmental Protection (U)
NE	-	Nuclear Energy (U)
NEPA	-	National Environmental Policy Act (U)
NESHAP	-	National Emissions Standards for Hazardous Air Pollutants (U)
NET	-	Nuclear Element Tests (U)
NFPA	-	National Fire Protection Association (U)
NGTSN	-	Noble Gas and Tritium Surveillance Network (U)
NLB	-	Nuclear Licensing Board (U)
NNFD	-	Naval Nuclear Fuel Division (U)
NNFD-RL	-	Naval Nuclear Fuel Division Research Laboratory (U)
NNWSI	-	Nevada Nuclear Waste Storage Investigation (U)
non-TRU	-	non-Transuranic (U)
NPDES	-	National Pollutant Discharge Elimination System (U)
NPR	-	New Production Reactor (U)
NRC	-	Nuclear Regulatory Commission (U)
NRF	-	Naval Reactors Facility (U)
NRS	-	Nevada Revised Statutes (U)
NTS	-	Nevada Test Site (U)
NVO	-	Nevada Operations Office (U)
NWCF	-	New Waste Calcining Facilities (U)
NWRS	-	National Wildlife Refuge System (U)
OSHA	-	Occupational Safety and Health Act (U)
OTV	-	Orbital Transfer Vehicle (U)
PBR	-	Particle Bed Reactor (U)
PIPE	-	Pulse Irradiation Particle Element (U)
PIPET	-	Particle Bed Reactor Integral Performance Elements Tests (U)
PMS	-	Propellant Management System (U)
PNT	-	Particle Nuclear Test (U)
PSD	-	Prevention of Significant Deterioration (U)
psi	-	Pounds Per Square Inch (U)
psia	-	Pounds Per Square Inch Absolute (U)
QTA	-	Qualification Test Article (U)
RCRA	-	Resource Conservation and Recovery Act (U)
RCS	-	Reactor Control System (U)

[redacted]

RCSC	-	Radiation and Criticality Safety Committee (U)
REECo	-	Reynolds Electrical and Engineering Company (U)
RESL	-	Radiological and Environmental Sciences (U)
RH	-	Remote Handled (U)
RIDP	-	Radionuclide Inventory and Distribution Program (U)
RIMS	-	Remote Inspection Maintenance System (U)
RWMP	-	Radiation Waste Management Project (U)
RWMS	-	Radioactive Waste Management Site (U)
SAR	-	Safety Analysis Report (U)
SARA	-	Superfund Amendment and Reauthorization Act (U)
SCEPS	-	Stored Chemical Energy Propulsions (U)
SDA	-	Subsurface Disposal Area (U)
[redacted]	-	[redacted] (U)
SDWA	-	Safe Drinking Water Act (U)
SEI	-	Space Exploration Initiative (U)
SEP	-	Safety and Environmental Protection (U)
SHPO	-	State Historic Preservation Officier (U)
SIP	-	State Implementation Plan (U)
SIRAS	-	Sandia Internal Review Approval System (U)
SMSN	-	Standby Milk Surveillance Network (U)
SMTS	-	Saddle Mountain Test Station (U)
SNL	-	Sandia National Laboratories (U)
SNM	-	Special Nuclear Material (U)
SOPs	-	Standard Operation Procedures (U)
SPRF	-	Sandia Pulse Reactor Facility (U)
SRC	-	Safety Review Committee (U)
SRSC	-	Sandia Reactor Safety Committee (U)
SSD	-	Safeguard and Security Division (U)
SST	-	Safe Secure Transport (U)
Sv	-	Sieverts (U)
SW	-	Solid Wastes (U)
TAN	-	Test Area North (U)
TCA	-	Trichlorethane (U)
TCE	-	Trichloroethylene (U)
TI	-	Transportation Index (U)
TLDs	-	Thermoluminescent Dosimeters (U)
TPA	-	Turbopump Assembly (U)
TRA	-	Test Reactor Area (U)
TRU	-	Transuranic (U)
TSD	-	Treatment, Storage, and Disposal (U)
TSP	-	Total Suspended Particulates (U)
[redacted]	-	[redacted] (U)
UN	-	United Nations (U)
USAF	-	United States Air Force (U)
USFWS	-	United States Fish and Wildlife Service (U)

USGS	-	United States Geological Survey (U)
USNRC	-	United States Nuclear Regulatory Commission (U)
UST	-	Underground Storage Tank (U)
VAFB	-	Vandenberg Air Force Base (U)
WINCO	-	Westinghouse Idaho Nuclear Company (U)
WIPP	-	Waste Isolation Pilot Plant (U)
WSMC	-	Western Space and Missile Center (U)

GLOSSARY (U)

(U) AIRDOS-EPA - A computational methodology for estimating environmental concentrations and dose to man from airborne releases of radionuclides.

(U) ALARA - As Low As Reasonably Achievable - An approach to radiation protection to control or manage exposures (both individual and collective to the work force and general public) as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit but a process, which has the objective of dose levels as far below applicable limits as possible.

(U) Ambient Air Quality Standards - Standards established on a state or Federal level which define the ceiling height for allowable ambient air quality concentrations for the designated criteria pollutants: NO_2, SO_2, CO, O_3, Pb, HC, & TSP.

(U) Atmospheric Dispersion - The process of air pollutants being dispersed in the atmosphere by the wind that carries the pollutants away from their source and by turbulent air motion that results from solar heating of the earth's surface and air movement over rough terrain and surfaces.

(U) Attainment Area - An area that has been designated by the U.S. EPA and the appropriate state air quality agency as having ambient air quality [levels below the ceiling levels defined under the National Ambient Air Quality Standards (NAAQS)].

(U) Automatic Reactor Shutdown - The Automatic Reactor Shutdown system is an automated procedure for shutting down a reactor in the event of failure of the reactor control system, excessive coolant outlet temperature, loss of electrical power, demand SCRAM via uplink command, or excessive neutron flux. This system uses two independent methods of achieving and maintaining subcriticality.

(U) Background Radiation - Ionizing radiation present in the environment from cosmic rays and natural sources in the earth; background radiation varies considerably with location.

(U) Baseline - The existing characterization of an area under no-project conditions.

(U) Collective Effective Dose Equivalent - The sum of the effective dose equivalents of all individuals in an exposed population. Collective Effective Dose Equivalent is expressed in units of person-rem (or person-sievert).

(U) Collective Dose Equivalent - The sum of the dose equivalents of all individuals in an exposed population. Collective dose equivalent is expressed in units of person-rem (or person-sievert).

(U) Committed Dose Equivalent (CDE) - The calculated dose equivalent projected to be received by a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does

[redacted]

not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert).

(U) <u>Confinement Disposal</u> - A type of waste burial that most often subject to confinement disposal are those which present special hazards or concerns to the public or environment.

(U) <u>Control Bunker</u> - The control bunker is an earth covered reinforced-concrete building in which the ground test activities would be controlled and monitored. Other projected activities performed from the control bunker include access control to the test station.

(U) <u>Coolant</u> - A substance, either gas or water, circulated through a nuclear reactor or processing plant to remove heat.

(U) <u>Core Release Fractions</u> - That fraction of the Fission Product Inventory released from the reactor core during either normal operation or during accidental release.

(U) <u>Core Release</u> - The quantity of radionuclides released from the reactor core. The result of the Fission Product Inventory and the Core Release Fraction

(U) <u>Cosmic Rays</u> - Electrons and the nuclei of atoms, largely hydrogen, that impinge upon the earth from all directions of space with nearly the speed of light. Also known as cosmic radiation; primary cosmic rays.

(U) <u>Critical Assembly</u> - An assembly of sufficient fissionable and moderator material to sustain a fission chain reaction at a low power level.

(U) <u>Cryogenic Fluids</u> - Those fluids that are below a temperature of 150k. In the context of this EIS, cryogenic fluids include liquid hydrogen and liquid oxygen.

(U) <u>Cryogenic Hydrogen</u> - Hydrogen at temperatures below 150k, which has been transformed from a gas to a liquid. Cryogenic hydrogen may be used as both a coolant and propellant.

(U) <u>Cultural Resources</u> - Any building, site, district, structure, object, data, or other material significant in history, architecture , archaeology, or culture.

(U) <u>Cumulative Effects</u> - The aggregation of project included effects within the project's Region of Influence. The term cumulative has also been used to denote aggregated effects over several years as against net effects in a given year.

(U) <u>Curie (Ci)</u> - The curie is the activity associated with 1 gram of Radium-226. The curie is also the activity of that quantity of radioactive material in which 3.7×10^{10} atoms are transformed per second. 1 curie = 3.7×10^{10} Becquerel (Bq).

(U) <u>Decommissioning</u> - The permanent removal from service of the surface facilities and components of the ground test facility.

[redacted]

(U) <u>Decontamination</u> - The removal of unwanted material (especially radioactive material from the surface of or from within other material.

(U) <u>Derived Air Concentration (DAC)</u> - Used for limiting radiation exposures through inhalation of radionuclides by workers. The values are based on eigher stochastic (committed effective dose equivalent) dose of 5 rem or a nonstochastic (organ) dose of 50 rem, whichever is more limiting.

(U) <u>Derived Concentration Guides (DCG)</u> - Reference values for conducting radiological environmental protection programs at operational DOE facilities and sites.

(U) <u>Dewar</u> - A double walled glass or metal flask container that is well insulated with a vacuum in the annulus. It is used for storing liquified gases and hot or cold beverages. Large vessels are used for truck and rail movement of liquified gases.

([redacted]) <u>Diffusion Process</u> - [redacted]. The diffusion process uses a chemical vapor.

(U) <u>Disturbed Area</u> - Specific land area which has had its surface altered by grading, digging, or other activities related to construction.

(U) <u>Dose Commitment</u> - Dose commitment is that total radiation dose equivalent, internal or external in origin, to the whole body or specified part of the body, that will be received during the 50-year period following the release of radioactive material to the specific environment. Dose quantities that apply to the "<u>Whole Body</u>" shall also apply to the head and trunk, active blood-forming organs, gonads, and lens of the eyes. Dose quantities that apply to "<u>Other Organs</u>" shall apply to those organs not specified above.

(U) <u>Dose Equivalent (H)</u> - The product of absorbed dose (d) in rads (or gray) in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent (H) is expressed in units of rem (or sievert).

(U) <u>Dynamometer</u> - An instrument used for measuring mechanical force.

(U) <u>EDE -Effective Dose Equivalent (H_E)</u> - The sum over specified tissues of the products of the dose equivalent in a tissue (H_T) and the weighting factor (W_T) for the that tissue, i.e., $H_E = W_T H_T$. The effective dose equivalent is expressed in units of rem (or sievert).

(U) <u>ETS Release Fractions</u> - The fraction of radionuclides sent to the ETS that are released from the Effluent Treatment System.

(U) <u>Effluent</u> - Waste material discharged into the environment. In the case of this EIS, the major effluent of concern is that produced by the testing of the ground test articles.

(U) <u>Effluent Treatment System (ETS)</u> - A system designed to remove fission contaminants generated as a result of some of the ground testing activities. The ETS would be designed to treat radioactive particulate, iodine, and noble gas releases.

(U) Emission Factor - The rate at which a pollutant is emitted from a point, line, or area source.

(U) Endangered Species - A species that is threatened with extinction throughout all or a significant portion of its range. Defined by the Endangered Species Act, as amended (16 USC 703 et seq.).

(U) Engine Nozzle - The engine nozzle is the orifice through which the hot hydrogen propellent is ejected to initiate thrust.

(U) Engine Integration Test (EIT) - The Engine Integration Test is a test designed to demonstrate the propellant management system without an operating reactor in the loop. Heat would be generated by combusting hydrogen in an oxygen-rich environment.

(U) Epicenter - The point on the earth's surface directly above the focus of an earthquake.

(U) Exposure rate (X) - The exposure per unit time.

(U) Fission Product Inventory - Those radionuclides created within the reactor core during operation (including the unreacted fuel material).

(U) Fuel Element - The smallest structurally discrete part of a reactor or fuel assembly that has nuclear fuel as its principal constituent. The term fuel element is a general term and a more precise term such as fuel pellet, plate, rod, pin, cluster, bundle or subassembly, or assembly should be used.

(U) Fuel Kernels - Fuel kernels are the center of the fuel particles which contain the enriched uranium.

([redacted]) Fuel Particle - A fuel particle is a tiny microsphere that contains fissile material. It consists of either a kernel of highly enriched uranium carbide, concentric carbon layers of varying densities, and one or more refractory coatings[redacted].

(U) Full-Scale Facility - The full-scale facility consists of the sub-scale facility expanded to accommodate the EIT, mini-GTA, GTA and QTA testing activities. Additional upgrade from the sub-scale facility includes additional testing cells, coolant storage and control instrumentation.

(U) Gelation Process - This is one of three processes used to create fuel kernels. The gelation process uses a chemical reaction that creates oxides.

(U) Gigawatts - a unit of power equal to 1 billion watts.

([redacted]) Ground Test Article (GTA) - The Ground Test Articles are a series of two to six reactors which, as they are tested, gradually approach the desired prototypic conditions of the Qualifying Test Article (QTA). The mini-GTAs are [redacted] while the full-scale GTAs are [redacted].

[redacted]

(U) Half-life - The time required for the activity of a radionuclide to decay to half its value; used as a measure of the persistence of radioactive materials. Each radionuclide has a characteristic constant half-life.

(U) Halogens - Any of the elements that form part of group VII A of the periodic table and exist in the free state normally as diatomic molecules, these include fluorine, chlorine, bromine, iodine, and astatine.

(U) Heliocentric Orbit - A sun-centered orbit.

([redacted]) Hot Hydrogen Gas Generator - This is a generator that generates hot hydrogen gas (approx 2700 K; 2430° C) by combusting hydrogen in an oxygen-rich environment. The hot-hydrogen gas generator is used as part of the Engine Integration Test.

[redacted]

(U) Inversion - A reversal of a normal atmospheric temperature gradient, causing increasing temperatures with height.

(U) Ionizing Radiation - Radiation that can displace electrons from atoms or molecules, thereby producing ions.

(U) Irreversible & Irretrievable Commitment of Resources - Involves land areas committed during operation, funding for construction and materials, chemicals, and water that would be consumed during construction and operation and would be unable to replace.

(U) Isotope - Isotopes of an element are atoms that contain the same number of positive nuclear charges and have the same extra-nuclear electronic structure, but differ in the number of neutrons.

(U) Isotope Effect - The effect on the atomic properties of isotopes of the same element between two molecules or between different positions in a single molecule.

(U) Joule - A unit of energy of work equivalent to 1 Watt per second, 0.737 foot-pound, or 4.18 calories.

(U) Kelvin (K) - A temperature scale that designates absolute zero as 0 K.

(U) Land Disposal Restrictions (LDR) - Hazardous wastes which are subject to restrictions for land disposal as identified and defined in 40 CFR Part 268.

(U) Level of Impact - For each environmental resource and its elements, there are specific definitions for negligible, low, moderate, and high impacts for the EIS.

(U) Linear Energy Transfer (LET) - The spatial energy distribution of radiation deposited per unit length of particle track, expressed as the amount of energy in Mev/um or Kev/um.

[redacted]

(U) Low Level Wastes (LLW) - All radioactive waste not classified as high-level waste, spent nuclear fuel, transuranic waste, uranium mill tailings or Mixed Waste. LLW can contain transuranic nuclides in concentrations not greater than 100 nanocuries per gram.

(U) Maximum Contaminant Level (MCL) - The maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system. MCL values are reported in the EPA National Primary Drinking Water Standards (40 CFR 141).

(U) Megajoules - A unit of energy. Work performed when power is expended at the rate of 1 watt for 1 second. The work performed by 1 newton acting through a distance of 1 meter. Million joules.

(U) Megawatts - a unit of power equal to 1,000,000 watts.

(U) Mesozoic - a period of geologic time extending from about 245 million to 66 million years ago.

(U) millirem - A fractional unit of rem. 1 millirem = 1 x 10^{-3}.

([redacted]) Mini-GTA - The mini-GTA is the [redacted].

(U) Mitigations - Methods to reduce or eliminate adverse project impacts.

(U) Mixed Wastes - Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively.

(U) Non-attainment Area - An area that has been designated by the U.S. EPA and appropriate state air quality agency as exceeding one or more National Ambient Air Quality Standards.

(U) Normal Operation - The range of full-power operation conditions that can be achieved when seasonal variations in ambient conditions are taken into account.

(U) Nuclear Element Tests (NET) - This is a series of tests designed to demonstrate the integrity and performance of fuel element designs under conditions of high temperature and moderate hydrogen flow.

(U) Nuclide - An atomic nucleus specified by its atomic weight, atomic number, and energy state.

(U) Operational Boundary - The operations boundary is the reactor building (or the nearest physical personnel barrier in cases where the reactor building is not a principal physical personnel barrier) where the reactor chief administrator has direct authority over all activities. The area within this boundary shall have prearranged evacuation procedures known to personnel frequenting the area.

(U) ORIGEN - An acronym for ORNL Isotope Generation. ORIGEN-2 is the second generation of the code.

(U) Particle Nuclear Tests (PNT) - Particle Nuclear Tests are a series of in-reactor tests to determine candidate fuel particle behavior and failure mechanisms when subjected to nuclear heating.

([redacted]) Particle Bed Reactor Integral Performance Element Test (PIPET) - This is a series of tests designed to demonstrate the reactor fuel elements operation at prototypic power densities, temperatures, pressures, flow rates, and power durations. The PIPET would consist of [redacted].

([redacted]) Particle Bed Reactor (PBR) - The Particle Bed Reactor is a nuclear reactor fueled by elements comprised of small microspheres placed in an annulus formed by a cold and hot frit. The reactor is cooled by cryogenic liquid hydrogen.

(U) Pasquill Stability Class - Stability classes ranging from A (extremely unstable) through F (Moderately Stable) indicate the turbulent nature of the atmosphere. Extremely unstable conditions enhance diffusion (generally reducing pollutant concentrations) while moderately stable conditions inhibit diffusion and pollutant dispersion.

(U) Plume - The elongated pattern of contaminated air or water originating at a point-source emission, such as a smokestack, or a waste source, such as a hazardous waste disposal site.

(U) Population Center Distance - The distance from a power or testing reactor to the nearest boundary of densely populated center containing more than 25,000 residents (see 10 CFR 73.2).

(U) Perennial Yield - The amount of water that can be withdrawn on an annual basis from a groundwater basin without depleting the reservoir.

(U) Propulsion System - In the context of this EIS, the propulsion system is the PBR reactor engine.

(U) Production Reactor - A reactor whose primary purpose is to produce fissile or other materials or to perform irradiations on an industrial scale. Unless otherwise specified, the term usually refers to a plutonium-production reactor. Reactors in this class include fissile material production reactor, isotope-production reactor, and irradiation reactor.

(U) Protected Area - An area encompassed by physical barriers to which access is controlled (see 10 CFR 73.2).

(U) Pulsed Irradiation Particle Element (PIPE) Tests - A series of tests to investigate the performance of single fuel elements at moderate temperatures and power densities using gaseous hydrogen coolant.

(U) Qualifying Test Article (QTA) - The Qualifying Test Article is a system which simulates the operation of the complete engine system at near prototypical flight conditions.

(U) Quaternary - A geologic period of the Cenozoic era extending from about 1.6 million years ago to the present.

(U) Radionuclide - An unstable nuclide that decays toward a stable state at a characteristic rate by the emission of ionizing radiation.

(U) Radioactive Waste - Materials from nuclear operations that are radioactive or are contaminated with radioactive materials , and for which use, reuse, or recovery are impractical.

(U) Radioactivity - The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

(U) Radioisotope - Nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons and that spontaneously emit particles or electromagnetic radiation.

(U) Reactivity Control - The reactivity control system is a system capable of controlling the power of the reactor.

(U) Region of Influence - The largest region which would be expected to receive measurable impacts from the proposed action.

(U) rem - The unit used to measure dose equivalent. The rem is the product of the absorbed dose (D in rads)in tissue, a quality factor (Q), and other modifying factors (N). (1 rem = 0.01 Sievert = 100 rem = 1 tissue).

(U) Remote Inspection and Maintenance System - Inspection and maintenance of radioactive or contaminated equipment by means of a manipulator or robot.

(U) Research Reactor - A research reactor is a device designed to support a self-sustaining neutron chain reaction for research, or developmental purposes, and which may have provisions for the production of nonfissile radioisotopes.

(U) Rural Zone - A rural zone is a sparsely populated but not directly controlled area or neighborhood where evacuation of all personnel can be achieved in less than 2 hours using available resources.

(U) SCRAM System - 1) A sudden shutting down of a nuclear reactor, usually by dropping safety rods, when a predetermined neutron flux or other dangerous condition occurs. 2) To close down a reactor by bringing about a scram.

(U) Sievert (Sv) - A unit used to measure dose equivalent. The Sievert is the product of the absorbed dose (D in gray) in tissue, a quality factor (Q), and other modifying factors (N). (1 Sv = 100 rem = 1 Joule/kilogram tissue).

[redacted]

(U) Significance of Impact - Determined by applying criteria established by the Council on Environmental Quality in regulation implementing the procedural provisions of the National Environmental Policy Act (40 CFR parts 1500-1508).

(U) Site Boundary - The site boundary is that boundary, not necessarily having restrictive barriers surrounding the operations boundary wherein the reactor administrator may directly initiate emergency activities. The area within the site boundary may be frequented by people unacquainted with reactor operation.

(U) Site-Specific - Characteristic of a geographically defined location that may vary considerably from characteristics of adjacent locations or the characteristics of a larger area within which the location in questions is contained.

(U) Solid Wastes - Waste material that is an essentially in a dry, solid form. Waste may include well-drained containers or liquids which have been entrapped or otherwise solidified so that they will retain their solid form without the presence of free liquids during handling, transportation, storage, or disposal. Viscous waste material is determined to be a solid by testing in accordance with American Society for Testing Materials Standards D4359, "Standard Test Method for Determining Whether a Material is a Liquid or a Solid."

(U) Source term (System Release) - The quantity of radionuclides released from the test system to the environment during either operational or accidental conditions. The Source Term is the product of the Fission Product Inventory, the Core Release Fractions, and the ETS Release Fractions.

(U) Special Nuclear Material - Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the NRC, pursuant to the provisions of section 51 of the Atomic Energy Act of 1954 determines to be special nuclear material.

(U) Specific Impulse (Isp) - Specific impulse is a measure of the effectiveness of rocket engine and is expressed in units of time (seconds); it represents the capability of generating a unit of force (pounds) for a given period of time (seconds) for a unit of propellant weight (pounds).

(U) Sub-Scale Facility - The sub-scale facility is the first phase of the ground test activity that is intended to accommodate the PIPET testing. The sub-scale facility would include a control bunker, data acquisition and instrumentation/control systems, a receiving and assembly facility, a test cell, a coolant supply system, an effluent treatment system, a remote inspection and maintenance system, roads and services, and safeguards and physical security.

(U) Supercritical Fluids Process - This is one of three processes used to create fuel kernels. This process involves the deposition of zirconium into a prous uranium-carbon kernel. Supercritical fluids are non-wetting dense gases and are obtained by controlling temperature and pressure in a controlled reaction chamber. They are used to carry the zirconium carbide precursors into the fine proosity of the kernel.

(U) Thermoluminescent Dosimeters - These instruments measure ionizing radiation exposures from natural radioactivity in the air and soil, cosmic radiation from outer space, fallout from

[redacted]

nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive emissions from site operation and other industrial processing.

(U) Threatened Species - A species that has the potential to become endangered. Defined by the Endangered Species Act, as amended (16 USC 703 et seq.).

(U) Thrust to Weight Ratio - This is the ratio of thrust divided by weight.

(U) Transuranic Waste (TRU) - Radioactive waste containing alpha-emitting radionuclides having an atomic number greater than 92 and half-lives greater than 20 years in concentrations greater than 100 nci/g.

(U) Turbo-Pump - An abbreviated form of turbine-pump, or regenerative pump: rotating vane device that uses a combination of mechanical impulse and centrifugal force to produce high liquid heads at low volumes.

(U) Unrestricted Area - An area to which access is not controlled for the purpose of protecting individuals from exposure to radiation and radioactive materials.

(U) Urban Boundary - The urban boundary means the nearest boundary of a densely populated area or neighborhood containing population of such number or in such a location that a complete rapid evacuation is difficult or cannot be accomplished within 2 hours using available resources.

(U) Wetlands - Areas defined by the prevailing vegetation types and soil moisture content and consisting of vegetation types and soil moisture content and consisting of vegetation typical of soils that are saturated for a major portion of the year.

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Donnelly, Kevin
The Harris Group
Civil/Environmental Engineer
M.S., Engineering Management, 1982
B.S., Civil Engineering, 1981
Years of Experience: 10
Role: Siting Analysis, Technical Review

Enright, Ann Marie
Dames & Moore
Project Engineer
M.S. Environmental Engineering/Toxicology, New Jersey Institute of Technology, 1986
B.S. Environmental Sciences, St. Johns University, 1984
Years of Experience: 5
Role: Risk Assessment

Feity, Major James R.
U.S. Department of Energy
M.S., Nuclear Engineering, Air Force Institute of Technology, 1986
B.S., General Engineering, U.S. Military Academy, 1976
Years of Experience: 16
Role: Research and Development Program Officer

Harmon, Charles D.
Sandia National Laboratories
U.S. Army Nuclear Power Program Graduate
NRC Licensed Senior Reactor Operator
DOE Certified Research Reactor Supervisor
Years Experience: 23
Role: Test Station Manager

Haupt, Cathy G.
Dames & Moore Special Services
Administrative Manager/Geographer
M.S. Science Education (Biology) Clarion University, 1983
B.S. Secondary Education (Geography/Environmental), Clarion, 1979
Years of Experience: 12
Role: Graphic/Technical Support

Horan, John
Grumman Corporation, Space and Electronics Division
M.S. Computer Science, New York Institute of Technolgy, 1988
B.S. Electrical Engineering, Manhattan College, 1957
Years of Experience: 34
Role: Technical Contributor/Review

Howroyd, G.C.
Dames & Moore
Air Quality Engineer
Ph.D., Mechanical Engineering, University of Waterloo, 1979
M.S., Mechanical Engineering, University of Waterloo, 1975
B.S., Mechanical Engineering, University of Waterloo, 1973

Johnson, Reginald F.
Dames & Moore Special Services
Word Processor
Years of Experience: 6
Role: Graphic/Technical Support

Kear, Ronald B.
Dames & Moore Special Services
Program Manager
B.S. Civil Engineering, San Jose State University, 1966
Years of Experience: 30
Role: Project Manager

Klock, Paul
B.S., Chemistry, University of San Fransisico, 1977
M.S., Chemistry, San Jose State University, 1984
Years of Experience: 15
Role: Team Leader of Four Engineers for WSMC Review

Langsted, Jim
Dames & Moore
Senior Health Physicist
M.S. Radiological Sciences, University of Washington, 1977
B.S. Psychology, University of Washington, 1975
Years of Experience: 16
Role: Health Physics

Leighton, Ann M.
Dames & Moore Special Services
Environmental Analyst/Biologist
B.S., Biology, University of Virginia, 1988
Years of Experience: 3
Role: Assistant Project Manager

Lewis, Charles R.
Dames & Moore Special Services
Geologist
B.A., Geology, Hamilton College , 1949
Graduate work, Harvard University and University of Colorado
Years of Experience: 40
Role: Physical Scientist

Ludewig, Hans
Brookhaven National Laboratory

McCollouch, Bill
Ph.D., Mechanical Engineering, Texas Tech, 1968
M.S., Mechanical Engineering, Texas Tech, 1964
B.S., Engineering Physics, Tesax Tech, 1963
Years of Experience: 24
Role: Safety & Environmental Task Leader

Pflaum, Timothy
U.S. Department of Energy, ES&H
M.S., Systems Management, American University, 1975
B.S., Business Economics, University of Maryland, 1970
Years of Experience: 20
Role: ES&H Coordinator and NEPA Compliance Officer/Headquarters review working group

Porter, Kenneth R.
Dames & Moore
Biologist
Ph.D, Vertebrate Ecology, University of Texas, 1962
M.S., Zoology, Oregon State University, 1959
B.S., Wildlife Management, University of Wyoming, 1953
Years of Experience: 36
Role: Biological Survey

Rubis, Andrew J.
Dames & Moore Special Service
Program Security Manager
Naval Officer Candidate School, Newport Rhode Island, 1988
B.A. International Studies, Johns Hopkins University, 1987.
Years of Experience: 5
Role: Security Administrator

Rushneck, Shelley A.
Dames & Moore Special Services
Environmental Analyst
B.S. Consumer Affairs, Indiana University of Pennsylvania, 1988
Years of Experience: 2
Role: Preparer

Travis, Richard K.
Dames & Moore Special Services
Senior Economist
M.A. Economic Geography, University of Pittsburgh, 1974
B.A. Physical Geography, California State College, 1967
Years of Experience: 18
Role: Quality Control/Editor

Walker, Larry D.
Louis Berger International, Inc.
Senior Planner
M.U.A., Urban Affairs, 1978
Years of Experience: 13
Role: Environmental Planner

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